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KNOWLES PUMPING MACHINERY

GENERAL CATALOG

1898

Engineering Mag.
MAY 1904

Catalogue Library
THE ENGINEERING MAGAZINE
120-122 Liberty Street, New York

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To Our Patrons.

IN THIS revised Catalogue we have endeavored to give full particulars and illustrations of as many designs as possible of the Knowles Improved Pumping Machinery, but the extent of our business is such that we cannot do the subject justice within the limits of a catalogue as convenient as this size is.

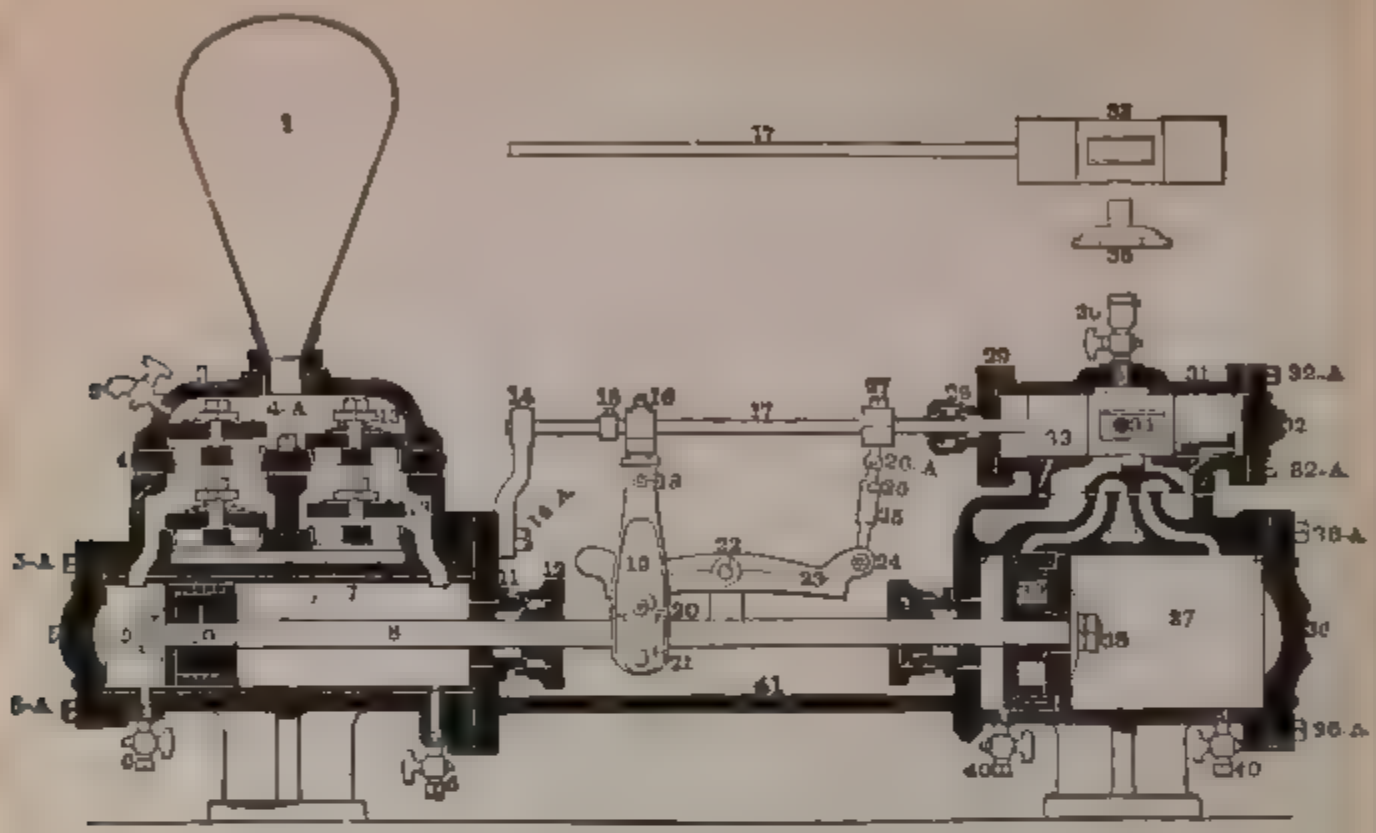
We are constantly bringing out new specialties in our line, and adapting the Knowles Patent Direct-acting Pumping System to new mechanical purposes which the growing industries of the country continually demand.

We therefore solicit correspondence from our patrons and others who do not find within these pages designs of pumping machinery adapted to their special requirements. We will gladly furnish them with plans and estimates on receipt of full particulars.

Our Guarantee.

Each and every pump built and sold by us is furnished fully guaranteed; in case of the failure of any of our machines to properly perform the service for which they are warranted, we hold ourselves under obligation to make the same fully satisfactory, or to refund the price paid for same.

May, 1898. Knowles Steam Pump Works.



NOTICE.

THAT the distinctive features of the Knowles valve motion and its great simplicity may be clearly understood, and the superior merits of the pump more fully appreciated, we call special attention to the following points, viz

1 Should a pump run longer stroke one way than the other simply lengthen or shorten the rocker connection (Part 25) so that rocker bar (Part 23) will touch rocker roller (20) equally distant from center (22)

2 Should a pump hesitate in making its return stroke, it is because rocker rollet (20) is too low and does not come in contact with the rocker bar (23) soon enough To raise it, take out rocker roler stud (20 A), give the set screw in this stud a sufficient downward turn, and the stud with its roller may at once be raised to proper height

3 Should valve rod (41) ever have a tendency to trend it slightly tighten up the valve rod stuffing box nut (38) When the valve motion is properly adjusted, tappet tip (19) should not quite touch collar (18) and clamp (21) Rocker roler (20) coming in contact with rocker bar (23) will reverse the stroke

4 The water piston is adjustable by means of segments that can be seen by taking off the follower, and the packing quickly set out to always insure perfect suction and at the same time not be so tight as to bind

From the above it will be seen that every wearing part is made adjustable, easily gotten at and to remedy any trouble it is rarely necessary to take a pump apart which are points that strongly commend our pump to every user

KNOWLES STEAM PUMP WORKS

KNOWLES PATENT

DIRECT-ACTING STEAM PUMP.

MANY a good steam pump is misused and condemned simply from want of a clear understanding of the principle on which it is constructed. Trouble caused by derangement in the steam end of a pump is often thought to exist in the water cylinder, or vice versa. It is not uncommon to find pumps badly set up or improperly selected for their work; pipes are often used that are too small in size or defective in their arrangement. Trouble arising from these and other mistakes are too often wrongly attributed to the steam pump. It is, therefore, very desirable that the attendant should be familiar with the machine, that he can at once locate any difficulty and remedy it with intelligence and promptness.

The KNOWLES DIRECT-ACTING STEAM PUMP is anything but an intricate or complicated machine. On the contrary it is very simple in its mechanism and readily understood; it requires but little trouble in its care or management, and very small expense is necessary to keep it in good repair.

EXPLANATION OF STEAM VALVES, ETC.

The prime advantage of the KNOWLES DIRECT-ACTING STEAM PUMP is its absolute freedom from what is termed a "*dead center*." This feature is secured by a very simple and ingenious mechanical arrangement, *i. e.*, by the use of an auxiliary piston which works in the steam chest and drives the main valve. This auxiliary or "chest piston," as it is called, is driven backward and forward by the pressure of steam, carrying with it the main valve, which valve, in turn, gives steam to the main steam piston that operates the pump. This main valve is a plain slide valve of the **B** form, working on a flat seat.

The chest piston is slightly rotated by the valve motion; this rotative movement places the small steam ports (which are located in the under side of the said chest piston) in proper contact with corresponding ports cut in the steam chest. The steam entering through the port at one end and filling the space between the chest piston and the head, drives the said piston to the end of its stroke and, as before mentioned, carries the main slide valve with it. (See illustration on opposite page.) When the chest piston has traveled a certain distance, a port on the opposite end is uncovered and steam there enters, stopping its further travel by giving it the necessary cushion. In other words, when the rotative motion is given to the auxiliary or valve-driving piston by the mechanism outside, it opens the port to steam admission on one end, and at the same time opens the port on the other end to the exhaust. Thus instant and *positive* motion is secured with but few working parts. There is no point in the stroke at which either the chest piston or the main piston is not open to direct steam pressure. Hence the immunity from any dead point whatsoever. A description of the

OPERATION OF THE PUMP

is as follows: The piston-rod, with its tappet arm, moves backward and forward from the impulse given by the steam piston. At the lower part of this tappet arm is attached a stud or bolt on which there is a friction roller.* This roller, coming in contact with the "rocker bar" at the end of each stroke, operates the latter. The motion given the "rocker bar" is transmitted to the valve rod by means of the connection between, causing the valve rod to partially rotate. This action, as mentioned above, operates the chest piston, which carries with it the main slide valve. The said valve giving steam to the main piston, the operation of the pump is complete and continuous. The upper end of the tappet arm does not come in contact with the tappets on the valve rod, except the steam pressure from any cause should fail to move the chest piston, in which case the tappet arm moves it mechanically. This makes the pump absolutely positive.

* This friction roller, with its bolt and nut, can be lowered or raised, when it is desired, to adjust the pump for a longer or shorter stroke.

(Above cut shows No. 4½ size.)

KNOWLES PATENT BOILER-FEED OR PRESSURE PUMP

KNOWLES PATENT

ıiler Feed or Pressure Pumps.

Arranged for Hot or Cold Water or other Liquids.

.evices have been introduced in the market for feeding boilers, but nothing has yet proved so ıd economical as a good steam pump. The Knowles Pump has withstood the test of many ice, and stands to-day preeminent for its record of efficiency and durability. In its present orm it is the most desirable boiler feeder to be found. Its improved valve motion and steam ıre the smoothest work under the most exacting conditions. The pump can be regulated to speed desired—an important feature in the feeding of boilers.

nanufacture of the Knowles Steam Pumps the best composition metal (Government standard) the piston rods, stuffing boxes, valve seats, and water cylinder linings. The water pistons ade of composition, and are packed with a special form of adjustable packing, adapted for ›r cold liquids. All parts are made to gauge, and are therefore interchangeable.

›umps have large direct water passages and full valve area, which admit of a speed that makes efficient *fire* pumps.

SIZES AND CAPACITIES.

ı Water ⊢ Cylinder.	Stroke.	Gallons per Stroke.	Capacity per Minute at Maximum Speed.		Steam Pipe.	Exhaust Pipe.	Suction Pipe.	Delivery Pipe.	Floor Space Required.	Telegraphic Code Word.
Ins	Ins.		Strokes.	Gals.	Ins.	Ins.	Ins.	Ins.	Ins.	
1½	3	.023	150	3½	¼	⅜	½	⅜	18 x 4	Forel
1¼	3	.031	150	4¾	¼	⅜	¾	½	18 x 5	Forelift
2	4	.05	150	7½	½	¾	1¼	1	31 x 6	Forename
2¼	4	.07	150	10½	½	¾	1¼	1	29 x 7	Forensal
2½	5	.11	150	16½	½	¾	1¼	1	32 x 7	Forepart
3¼	7	.25	125	31	¾	1	2	1½	44 x 10	Forerank
3¼	7	.34	125	42	¾	1	2	1½	44 x 10	Foreread
4	7	.39	125	49	1	1¼	2½	2	45 x 10	Forerun
4½	10	69	100	69	1	1¼	3	2½	56 x 16	Foresail
5	10	.85	100	85	1	1¼	3	2½	56 x 16	Foresay
5	12	1.02	100	102	1	1¼	4	4	64 x 16	Foresee
6	12	1.47	100	147	1¼	1½	4	4	68 x 19	Foreship
7	12	2.00	100	200	2	2½	5	5	68 x 19	Forest
8	12	2.61	100	261	2	2½	5	5	68 x 20	Forestay
10	16	5.44	75	408	2½	3	6	6	81 x 21	Forested

LARGER SIZES ON HAND OR TO ORDER AT SHORT NOTICE.

›rdering a pump, please answer the following questions:

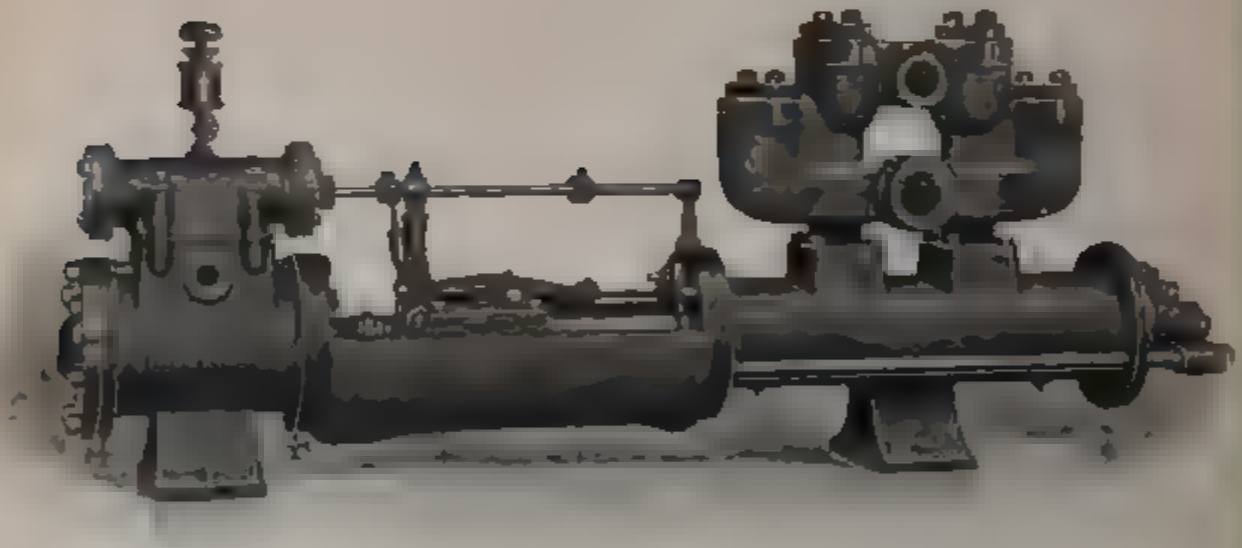
ıether for hot or cold water? 2d. To what height is water to be lifted by suction? 3d. Length pipe? 4th. Against what pressure or height is water to be forced? 5th. Amount of water r hour?

ıs. 0, 1, 2, 3, 4, and 4½ pumps are provided with hand power attachments.

ıtent Hand Power Attachment is invaluable, as the pump can be used, when steam is down, ›oilers after "blowing off," washing decks, fire purposes, etc. The Hand Lever can be easily ›y simply lifting it from the pump.

not recommend the use of copper air chambers, as experience has shown they are unreliable, for pressures above 100 pounds. *We will furnish* copper air chambers, however, if required, ›. 3 to No. *10 inclusive, at a slight additional charge.*

ı except No. 000 and No. 00 are good for 250 feet lift, for mine use, or for 125 pounds pressure ding. *Sizes No. 000 and No. 00 are good for* 100 pounds pressure.



KNOWLES PATENT PLUNGER PUMP.

Double-Acting.

Plunger Pumps—Double Acting

For Feeding Boilers, Pumping Water containing Sediment or Grit, etc.

Plunger pumps for boiler feeding, especially under the higher range of pressures, have cert advantages over "piston" pumps. They are very efficient and remarkably durable—the only wear part in the pump end being the packing of the plunger stuffing boxes. No leak can occur there with being observed, and easily stopped by setting up the packing. The plunger not touching the pu castings, there is no cutting or wear, consequently they require no reboring or refitting, like pis pumps, when working on gritty or sandy water.

As feed pumps, where very high steam pressure is carried (300 lbs. or less), the Knowles Plun Pumps **have no equal.** They have a splendid record in places where the work is very severe and c tinuous, such as found in rolling mills, blast furnaces, and sugar refineries. They are also particula adapted for pumping gritty or muddy water from mines, quarries, wells, pits, and similar places.

These pumps are very strong and compact. The piston rods do not enter the pump cylinders, a are therefore not exposed to the action of the water. The plungers are connected by substantial s rods and crossheads. The water valves are of special form, made of gun metal composition or rubb according to circumstances. There is a cover over each valve, giving quick and easy access to same.

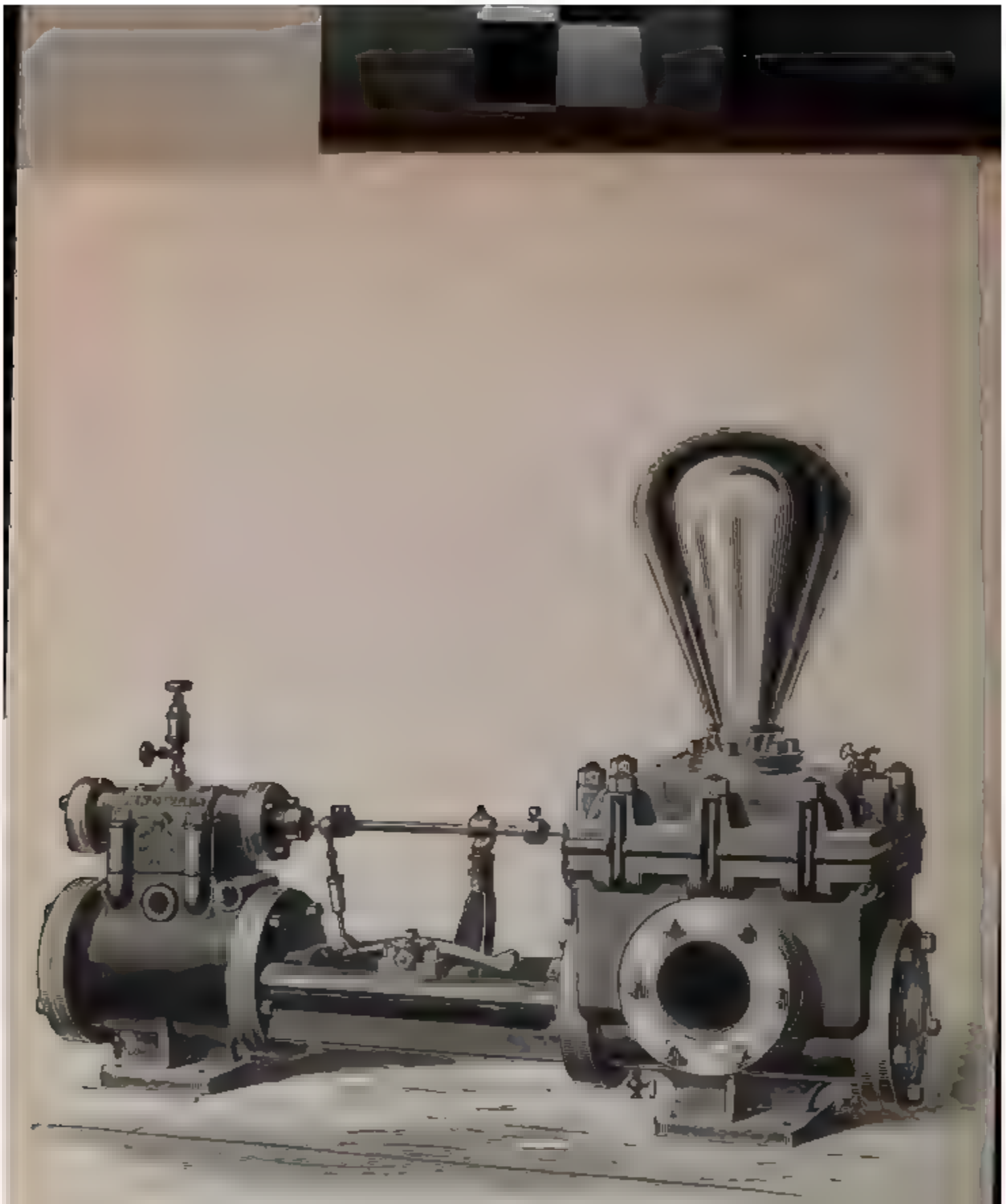
SIZES AND CAPACITIES.

Steam Cylinder	Water Plungers.	Stroke.	Gallons per Stroke.	Capacity per Minute at Maximum Speed.		Steam Pipe.	Exhaust Pipe.	Suction Pipe.	Delivery Pipe.	Floor Space Required.	Telegraphic Code Word.
Ins.	Ins.	Ins.		Strokes.	Gals.	Ins.	Ins.	Ins.	Ins.	Ins.	
4	2½	5	.11	150	16½	½	¾	1¼	1	57 x 10	Forewarn
5½	3¼	7	.25	125	31	¾	1	2	1½	72 x 12	Forewind
6	3¼	7	.33	125	42	¾	1	2	1½	72 x 12	Forewish
7½	4½	10	69	100	69	1	1¼	2½	2	92 x 12	Forfex
8	5	10	.85	100	85	1	1¼	3	2½	92 x 12	Forger
8	5	12	1.02	100	102	1	1¼	3	2½	112 x 12	Forgetful
10	6	12	1.47	100	147	1¼	1½	3½	3	112 x 22	Forgetting
12	6	12	1.47	100	147	2	2½	3½	3	114 x 22	Forgive
12	7	12	2 00	100	200	2	2½	5	4	120 x 27	Forgiving
14	7	12	2.00	100	200	2	2½	5	4	120 x 27	Forgotten
14	8	12	2 61	100	261	2	2½	5	4	124 x 27	Forkedly
16	8	12	2.61	100	261	2½	3	5	4	124 x 28	Forkhead
18	10	16	5.44	75	408	3½	4	8	6	164 x 30	Forkless

HEAVY PATTERN, FOR 300 LBS. WATER PRESSURE.

7½	3¼	10	.47	100	47	1	1¼	2	1½	92 x 12	Iberico
8	4	12	.65	100	65	1	1¼	2½	2	112 x 12	Ibexes
8	5	12	1.02	100	102	1	1¼	3	2½	112 x 12	Ibhar
10	5	12	1.02	100	102	1¼	1½	3	2½	112 x 12	Ibiapaba
10	6	12	1.47	100	147	1¼	1½	3½	3	112 x 22	Ibicara
12	6	12	1.47	100	147	2	2½	3½	3	114 x 22	Ibicencas
12	7	12	2.00	100	200	2	2½	5	4	120 x 27	Ibicinos
14	7	12	2.00	100	200	2	2½	5	4	120 x 27	Ibidion
14	8	12	2.61	100	261	2	2½	6	5	124 x 27	Ibilitaet
16	8	18	3.91	67	261	2½	3	6	5	164 x 30	Ibiracoa
16	9	18	4.96	67	332	2½	3	8	6	164 x 30	Ibiride
18	9	18	4.96	67	332	2½	3	8	6	172 x 30	Ibiscorum

All the working parts *of these pumps are* made to gauge, and are therefore **interchangeal** ***Duplicate parts can be quickly substituted when*** old parts are worn or broken.



KNOWLES PATENT TANK PUMP.

For Light Service.

Size, 8 x 8 x 12

KNOWLES PATENT

Tank or Light Service Pumps.

For pumping water or other liquids to limited heights and distances these pumps possess spec
dvantages; they combine *large pumping capacity* with small expenditure of steam. The steam cylinde
n proportion to the pump cylinders, are made smaller in diameter than with the regular pressure pump
nd consequently the first cost is less—for *amount* of water pumped. These pumps are principally us
t railroad water stations, gas and oil works, bleacheries, tanneries, refineries, plantations, distilleri
tc. A variety of valves are used adapted for pumping hot, cold, thick, thin, alkaline, or other liqui
For Quarries and Clay Pits, also for coffer dams, tunnels, foundation pits, ore beds, sewerage, a
rrigating purposes, these pumps are especially adapted, having large water passages and valve opening

SIZES AND CAPACITIES.

Steam Cylinder	Water Cylinder	Stroke.	Gallons per Stroke	Capacity per Minute at Maximum Speed.		Steam Pipe.	Exhaust Pipe.	Suction Pipe.	Delivery Pipe.	Floor Space Required.	Telegraphic Code Word
Ins.	Ins.	Ins.		Strokes.	Gals.	Ins.	Ins.	Ins.	Ins.	Ins.	
3¼	3¼	4	.15	125	18	½	¾	2	1½	32 x 9	Forktail
4	4	5	.27	125	33	½	¾	2	1½	35 x 9	Forky
5	4	7	.39	125	49	¾	1	2½	2	44 x 9	Forlay
5½	5½	7	.72	125	90	¾	1	3	2½	45 x 10	Forlie
6	5½	7	.72	125	90	¾	1	3	2½	45 x 13	Formal
6	6	12	1.47	100	147	¾	1	4	4	66 x 14	Formally
6	7	12	2.00	100	200	¾	1	5	5	66 x 14	Formate
7½	7	10	1.66	100	166	1	1¼	5	5	56 x 14	Formerly
7½	7½	10	1.91	100	191	1	1¼	5	5	56 x 14	Formful
8	6	12	1.47	100	147	1	1¼	4	4	66 x 14	Formic
8	7	12	2.00	100	200	1	1¼	5	5	66 x 14	Formill
8	8	12	2 61	100	261	1	1¼	5	5	66 x 15	Forpass
8	9	12	3.30	100	330	1	1¼	6	6	67 x 25	Forpine
8	10	12	4.08	100	408	1	1¼	6	6	67 x 25	Forsake
10	9	16	4.40	75	330	1¼	1½	6	6	89 x 25	Forsaking
10	10	12	4.08	100	408	1¼	1½	6	6	69 x 25	Forslack
10	10	16	5.44	75	408	1¼	1½	6	6	89 x 25	Forster
10	12	12	5.87	100	587	1¼	1½	8	6	69 x 25	Forswear
10	12	16	7 8₃	75	587	1¼	1½	8	6	89 x 28	Forswonk
12	10	12	4.08	100	408	2	2½	6	6	69 x 25	Forswore
12	10	16	5.44	75	408	2	2½	6	6	89 x 25	Forte
12	12	12	5.87	100	587	2	2½	8	6	70 x 25	Forthink
12	12	16	7.83	75	587	2	2½	8	6	89 x 28	Fortin
12	14	16	10.66	75	800	2	2½	10	8	89 x 28	Fortitude
14	12	12	5.87	100	587	2	2½	8	6	70 x 25	Fortlet
14	12	16	7.83	75	587	2½	3	8	6	89 x 28	Fortress
14	14	12	8.00	100	800	2	2½	10	8	78 x 28	Fortuitous
14	14	16	10.66	75	800	2½	3	10	8	89 x 28	Fortuity
14	14	24	16.00	50	800	2½	3	10	8	108 x 28	Forum
14	16	16	14.92	75	1020	2½	3	12	10	89 x 29	Forwaste
14	16	24	20.88	50	1044	2½	3	12	10	108 x 29	Forweary
16	14	16	10.66	75	800	2½	3	10	8	90 x 28	Forweep
16	14	24	16.00	50	800	2½	3	10	8	114 x 28	Fosse
16	16	16	14.92	75	1020	2½	3	12	10	96 x 29	Fossores
16	16	24	20.88	50	1044	2½	3	12	10	114 x 29	Fossroad
16	18	24	26.44	50	1322	2½	3	12	10	118 x 32	Fother
16	20	24	32.64	50	1632	2½	3	14	12	118 x 32	Fougade
18	16	24	20.88	50	1044	3½	4	12	10	118 x 29	Foughten
18	18	24	26.44	50	1322	3½	4	12	10	118 x 32	Foulder
18	20	24	32.64	50	1632	3½	4	14	12	118 x 32	Fouled
18	22	24	39 50	50	1975	3½	4	14	14	120 x 35	Fouling
18	24	24	47.00	50	2350	3½	4	16	16	132 x 39	Foulingly
20	18	24	26.44	50	1322	3½	4	12	10	128 x 32	Foully
20	20	24	32.64	50	1622	3½	4	14	12	128 x 32	Foumart
20	22	24	39.50	50	1975	3½	4	14	14	128 x 35	Founded
20	24	24	47.00	50	2350	3½	4	16	16	132 x 39	Fount

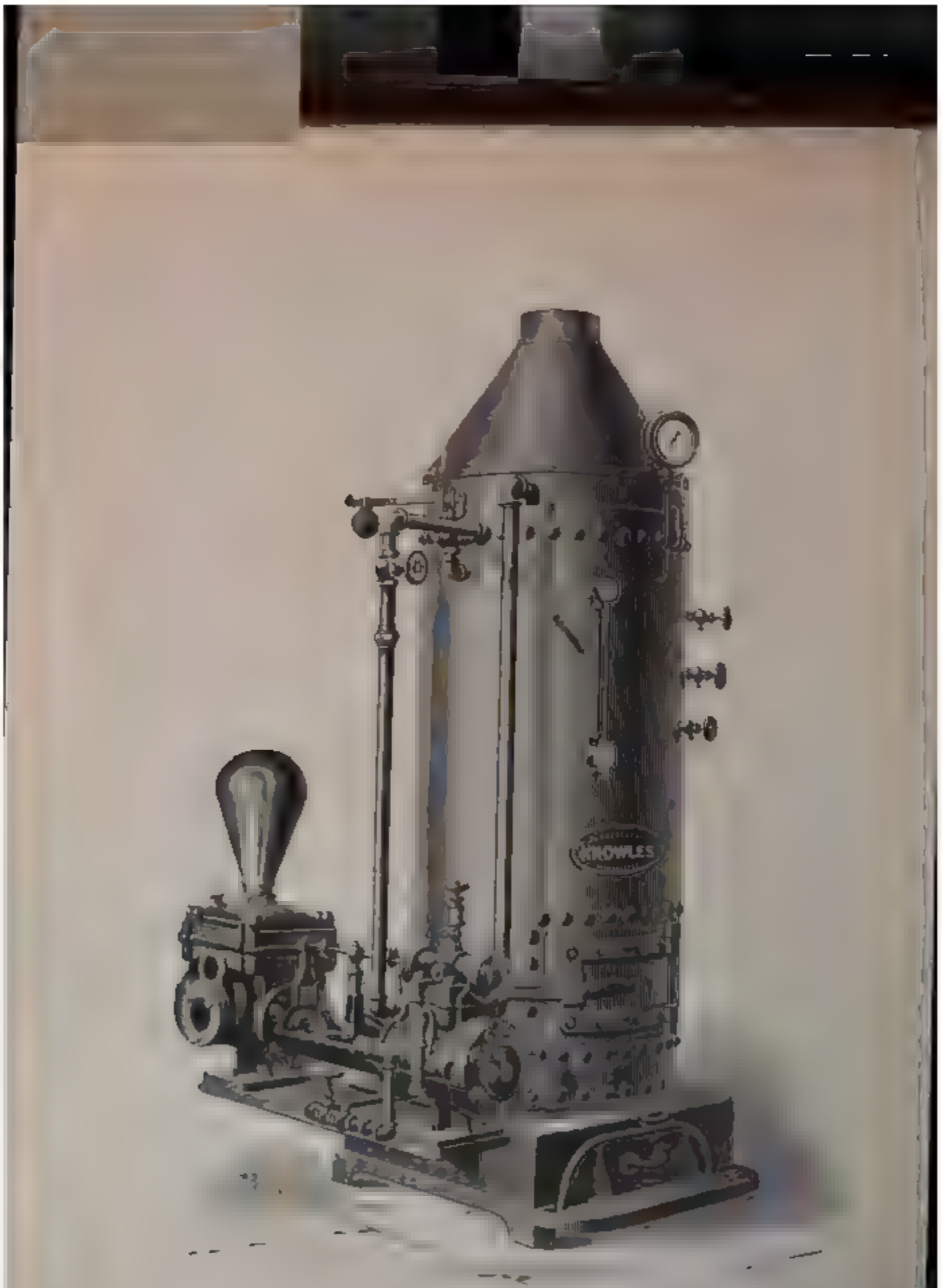
ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

The water cylinders are arranged with *composition* linings, valve seats, valve bolts, water pistor
and piston rods: the water pistons are packed with a special form of adjustable packing.

Auxiliary Boiler Feed Pumps (single action plungers) attached when required. Prices extra. Pum
with water cylinders entirely of COMPOSITION, EXTRA. The hand-power attachment applied to the fi
four sizes.

☞ In ordering, parties will please state fully the duty to be performed, also size and length of pip

All sizes *up to 8 x 8 x 12 inclusive are of the "flat cap"* pattern, good for water pressures correspo
ing to 100 feet head or less. Larger sizes have water cylinders of the "close clearance" type, suited
15 feet head, or less. Copper air chambers will be furnished, if required, at a slight additional charg



KNOWLES COMBINED BOILER AND PUMP

Regular Upright Tubular Boiler

KNOWLES PATENT

COMBINED BOILER AND PUMP.

(REGULAR UPRIGHT TUBULAR BOILER.)

Complete with Auxiliary Boiler Feed Pump, Base Plate, Smoke Bonnet, Grate Bars, Gauge Cocks, Steam Gauge, Water Gauge, Safety Valve, Globe Valves, Blow-off Cocks, Steam and Exhaust Pipes, Boiler Feed Connection, Valves, Unions and Necessary Fittings, etc.

THIS combination of Knowles Improved Steam Pump with Upright Tubular Boiler and fixtures complete is the most compact, serviceable and inexpensive machine of its kind for supplying water to hotels, public buildings and residences; also for use in railroad water stations, brick-yards, tanneries, quarries, etc.

The attention of railroad officials is particularly called to the especial advantage of this light, portable and convenient pumping apparatus for the water supply of tanks at watering stations. The entire machine can be placed at the point from which the water is to be taken, and the water forced to any distance and height required.

It does not need a skilled mechanic in setting up or operating it. A person of ordinary intelligence can be taught its management in a few hours' time.

The whole apparatus is of the best manufacture, the boiler being perfectly safe and guaranteed to 100 lbs. pressure (tested to 200 lbs.) per square inch. When water is to be forced not higher than 50 to 75 feet, the "Tank Pumps" are preferable and less expensive. Auxiliary Plunger Pumps for feeding the boilers are attached to the main pumps without additional charge.

SIZES, CAPACITIES AND PRICES:

Size No.	Steam Cylinder. Inches.	Water Cylinder. Inches.	Stroke. Inches.	Gallons per Stroke.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipe. Inches.	Delivery Pipe. Inches.	Floor Space Required. Inches.	Price, Complete
000	2½	1½	3	.023	¼	⅜	½	⅜	28 x 31	
00	3	1¾	3	.031	¼	⅜	¾	½	28 x 31	
0*	3¼	2	4	.05	½	¾	1¼	1	37 x 39	
1*	3½	2¼	4	.07	½	¾	1¼	1	38 x 40	
2*	4	2½	5	.11	½	¾	1¼	1	38 x 40	
3*	5	3¼	7	.25	¾	1	2	1½	40 x 44	
4*	5½	3½	7	.34	¾	1	2	1½	40 x 44	
4½	7	4	7	.39	1	1¼	2½	2	40 x 46	
5	7	4½	10	.69	1	1¼	3	2½	54 x 58	
6	7½	5	10	.85	1	1¼	3	2½	56 x 58	
6½	8	5	12	1.02	1	1¼	4	4	58 x 58	
7	10	6	12	1.47	1¼	1½	4	4		
8	12	7	12	2.00	2	2½	5	5		
9	14	8	12	2.61	2	2½	5	5		
TANK PUMPS.										
	*4	4	5	.27	½	¾	2	1½	38 x 40	
	*5½	5½	7	.72	¾	1	3	2½	40 x 48	
	6	6	12	1.46	¾	1	4	4	58 x 58	
	7½	7½	10	1.99	1	1¼	5	5	56 x 58	
	8	8	12	2.65	1	1¼	5	5	58 x 58	
	10	10	12	4.08	1¼	1½	6	6		
	10	10	16	5.43	1¼	1½	6	6		

LARGER SIZES, WITH UPRIGHT, HORIZONTAL, LOCOMOTIVE OR PATENT BOILERS, TO ORDER.

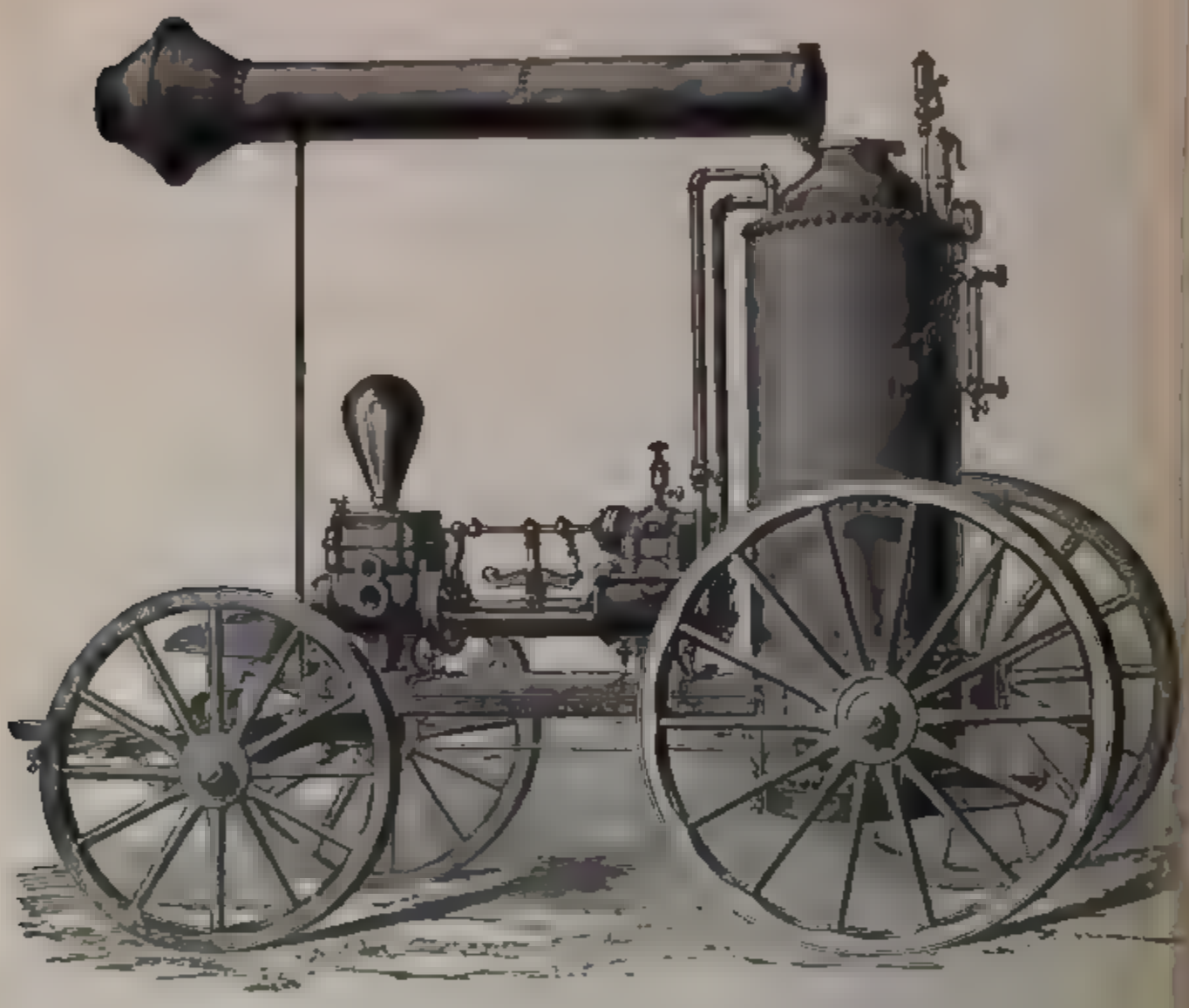
In setting up our Combined Boiler and Pump no trouble is liable to occur, as all the parts are carefully fitted, properly numbered or marked, and every piece inspected before the apparatus is taken apart for shipment.

The pumps marked * are provided with our Patent HAND-POWER ATTACHMENTS, which are very convenient for filling the boilers (after "blowing-off") or pumping when steam is down.

In ordering, parties will please state fully the particulars of duty to be performed.

EVERY MACHINE FULLY GUARANTEED.

☞ For PORTABLE Boiler and Pump mounted on wheels, see next two pages.



KNOWLES PATENT PORTABLE BOILER AND PUMP.

Mounted on Wheels.

KNOWLES PATENT

PORTABLE BOILER AND PUMP.

Mounted on Wheels Ready for Use.

THIS Portable Upright Boiler and Pump was designed expressly for the West Indies, South American and Southern trade, and is especially adapted for irrigating, drainage and fire service, also for general use about plantations, public and private grounds, etc.

This arrangement has many advantages over other mounted boilers and pumps heretofore offered. It is of very light draft, being mounted on high, wide-faced wheels, and can be easily moved from one place to another over the roughest roads. Two horses or a yoke of oxen are able to transport it. It cannot be easily upset, because three-fourths of the entire weight rests immediately above and below the axles. The steam pump is conveniently placed in a horizontal position, and being entirely independent does not strain or injure the boiler, and is not affected by the heat.

The boiler is made in the strongest manner possible of the best Pennsylvania C. H. No. 1 WROUGHT IRON throughout. The running gear is of the most approved form. The bottom of the ash-pan is fifteen inches above the ground, and by its removal nearly two feet clear under the boiler is obtained.

LIST OF SIZES AND PRICES:

HEAVY PRESSURE PUMPS.	Price.	LIGHT SERVICE PUMPS.	Price.
6 H. P. Boiler and No. 3 Pump,	$	6 H. P. Boiler and 5½, 5½, 7 Pump,	$
6 " " " " 4 "		6 " " " 6, 6, 12 "	
6 " " " " 4½ "		6 " " " 6, 7, 12 "	
8 " " " " 5 "		8 " " " 7½, 7½, 10 "	
8 " " " " 6 "		8 " " " 8, 8, 12 "	
8 " " " " 6½ "		8 " " " 8, 9, 12 "	
12 " " " " 7 "		8 " " " 8, 10, 12 "	
12 " " " " 8 "		12 " " " 10, 10, 12 "	
		12 " " " 10, 12, 12 "	

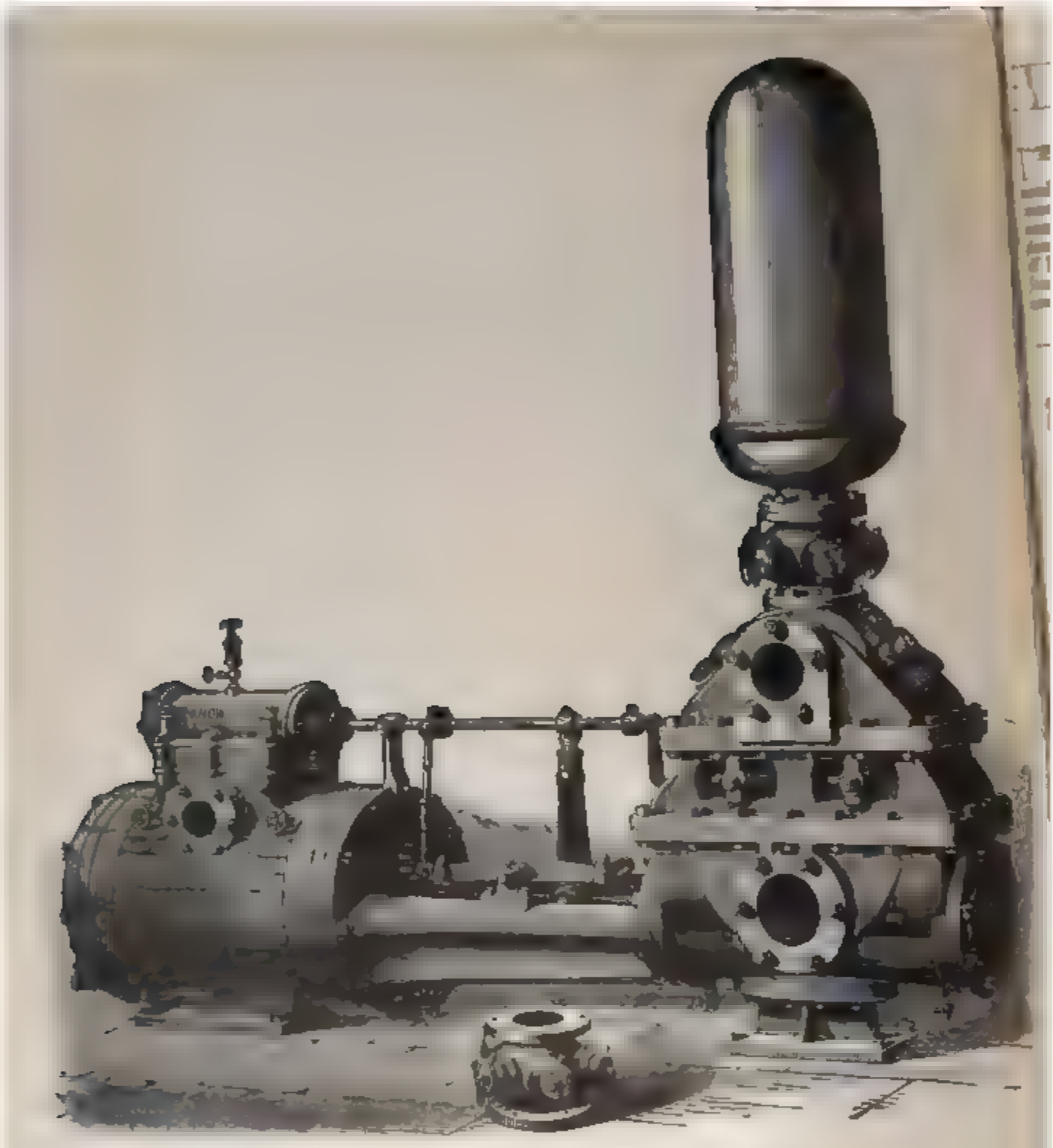
FOR SIZES OF PIPE CONNECTIONS, CAPACITIES, ETC., SEE PAGES 5 AND 9.

The entire machine is so constructed that it can be taken apart and boxed or crated in very compact form, thus making it convenient for shipping, and avoiding excessive freight charges.

IF PREFERRED WE FURNISH OUR STEAM PUMPS AND VERTICAL BOILERS MOUNTED ON LOW PLATFORM TRUCKS, WITH BROAD-FACED WHEELS OF SMALL DIAMETER. ALSO, PUMPS MOUNTED ON LOCOMOTIVE BOILERS OR BOILERS OF THE "SHAPLEY" PATENT.

Prices and further particulars given on application.

EVERY MACHINE FULLY WARRANTED.



KNOWLES PATENT FIRE PUMP.

Double Cap Pattern

[redacted]

KNOWLES PATENT

FIRE PUMPS—DOUBLE CAP PATTERN.

For Factories, Warehouses, Public Buildings, Coal Breakers, etc.

THESE pumps are built from special patterns embodying all the latest improvements. They are of superior design, construction and finish throughout. The castings are very heavy, and the various metals are distributed with a view to the greatest strength and durability. The water cylinders are lined with gun-metal composition *cast linings*, and the valve seats, valve bolts, water pistons and piston-rods are made of the same metal. The water valves are of the best vulcanized rubber, and their springs of phosphor bronze; the valve plates are independent removable castings. The valve area and water passages are made very large to admit of high piston speed—an important feature! The steam valve chest is fitted with our Patent Composition Jacket, which effectually prevents the sticking of the valve by corrosion, or from unequal expansion, and insures the *instant starting* of the Pump, even after months of disuse.

SIZES, CAPACITIES AND PRICES:

Size.	Steam Cylinder. Inches.	Water Cylinder. Inches.	Stroke. Inches.	Gall'ns per Stroke.	* Capacity per Minute at Ordinary Speed.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipe. Inches.	Delivery Pipe. Inches.	† Distance Streams Thrown. Feet.	Floor Space Required. Inches.	Price.
A	10	5	12	2.02	102 gals.	1¼	1½	4	4	150	67 x 16½	
AA	12	5	12	2.02	102 "	2	2½	4	4	175	67 x 16½	
B	12	6	12	2.47	147 "	2	2½	4	4	175	67½ x 16½	
BB	14	6	12	2.47	147 "	2	2½	4	4	200	67½ x 16½	
C	14	7	12	2.20	200 "	2	2½	5	5	200	69¼ x 18½	
CC	16	7	12	2.00	200 "	2½	3	5	5	200	69¼ x 20½	
D	16	8	18	3.91	261 "	2½	3	6	6	200	75 x 20½	
DD	18	8	18	3.91	261 "	2½	3	6	6	225	78 x 23	
E	18	9	24	6.60	330 "	2½	3	6	6	225	108 x 23	
EE	20	9	24	6.60	330 "	2½	3	6	6	250	108 x 25½	
F	20	10	24	8.16	408 "	2½	3	6	6	225	108 x 25½	
FF	22	10	24	8.16	408 "	3	3½	6	6	250	108 x 28	
G	24	12	24	11.75	587 "	3	4	8	6	225	109 x 30	
GG	26	12	24	11 75	587 "	3½	4	8	6	250	109 x 34	
H	28	14	24	16.00	800 "	4	4½	10	8	225	112 x 36	
HH	30	14	24	16.00	800 "	4	5	10	8	275	112 x 39½	
I	32	16	24	20.88	1044 "	4½	5	12	10	225	114 x 40½	
II	34	16	24	20.88	1044 "	4½	5	12	10	250	114 x 41½	
J	36	18	24	26.44	1322 "	4½	5	12	10	225	114 x 42	
JJ	38	18	24	26.44	1322 "	5	6	12	10	250	114 x 44	
K	42	20	36	48.96	1632 "	5	6	14	12	250	165 x 48	
SHORT STROKE.												
D	16	8	12	2 61	261 gals.	2½	3	5	5	2 10	69½ x 20½	
E	18	9	16	4.40	330 "	3½	4	6	6	200	84 x 25½	
F	20	10	16	5.44	408 "	3½	4	6	6	225	84 x 25½	
FF	22	10	16	5 44	408 "	4	4½	6	6	250	84 x 28	

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

* This column gives the capacity of each pump at the rate of 100 feet piston travel per minute. This speed can be increased in case of emergency.

† This gives approximately the distances that streams can be thrown *horizontally* with moderate steam pressure; the *vertical* distance would be about twenty-five per cent less. For further particulars see table of "Fire Streams" on page 100.

Each pump has suction and discharge openings on *both* sides, consequently connections can be made on either side desired. In addition to the regular discharge outlets, we furnish, when required, two, four and six way hose connections, as shown in opposite illustration, at a slight additional cost.

☞ INDEPENDENT STATIONARY FIRE APPARATUS, with "quick steaming" boilers, pipes, etc, adapted for towns and villages, factories, grain elevators, store-houses, public buildings, etc. See next two pages.

IMPROVED AUTOMATIC PUMP REGULATOR.

For operating fire pumps on the automatic system (where they are kept continually under steam pressure) we furnish an Improved Regulator which maintains any desired water pressure upon the pipes. This regulator is positive in its action, and very sensitive, shutting off the steam and stopping the pump when the desired pressure has been reached, and again starting it on the slightest reduction of the pressure. Prices as follows:—
For 1 inch steam pipe, 1¼ inch, 1½ inch, 2 inch, 2½ inch, 3 inch, 3½ inch, 4 inch, .

RUBBER AND LINEN HOSE, HOSE PIPES, COUPLINGS, STRAINERS, ETC., at lowest rates.

KNOWLES INDEPENDENT STATIONARY "QUICK STEAMING" FIRE APPARATUS.

KNOWLES PATENT

INDEPENDENT

QUICK-STEAMING FIRE APPARATUS.

Complete, Ready for Operation.

THE engraving on opposite page represents an Independent Stationary Steam Fire Apparatus as erected by the Knowles Steam Pump Works. It is so situated and connected by a system of pipes, and the boilers so constructed, *that steam can be generated, and the whole apparatus put in operation by one man, in less than six minutes' time*, and from one to ten streams concentrated on any given point in their establishment, thereby affording the most complete and efficient protection against the ravages of fire.

The boilers were tested to 500 lbs. pressure, and are therefore absolutely safe at a working pressure of 100 lbs. of steam; they are of improved construction, and are durable, compact and very reliable.

This system of fire extinguishing apparatus is designed for small towns and villages, also for large manufacturing or kindred establishments that are usually situated outside of cities. We are prepared to furnish estimates for the entire cost of this apparatus, including pumps, boilers, building, pipes, hose, etc., in short, everything complete, ready for instant use.

Independent stationary steam fire pumps are not only recommended by *every* insurance company, but are by many companies demanded as a condition before granting policies.

The Knowles Steam Fire Pump, with independent boiler, combines every requisite for a first-class stationary fire apparatus, capable of throwing continuously from one to ten fire streams over any warehouse, factory or steeple; with suitable underground pipes, hydrants, etc., a number of fire streams, in different parts of the town or village, can be thrown to any distance necessary, and at a fraction of the cost required to maintain steamers and their appliances.

The economy of stationary fire engines, as compared with hand fire engines or "steamers," is worthy of careful consideration. To throw the same number of streams as the apparatus shown on the opposite page, would require *four* "first-class" steamers. For each of these would be needed engine house and stable (not less than 25x100 feet) horses, harness, coal wagon, etc. In addition to this, provision must be made with cisterns, tanks, or other means for *water supply* in every part of the town. The number of men required for each steamer would be at least three to every one necessary for the stationary apparatus, while the expense for cleaning and repairs would be more than quadrupled. Compare the first cost of all this, and the very much increased cost of maintenance, with the entire cost of the works here described, and it will be found that in every way the advantages are altogether in favor of the stationary system as arranged with the Knowles Fire Pumps.

Where valuable property is to be protected, it is no unfrequent occurrence that the reduction in the rates of insurance will in the first year about equal the cost of a pump, boiler and a complete outfit, to say nothing of the extra protection to property *not* insured.

Estimates, plans and specifications furnished on application.

THE KNOWLES FIRE PUMPS, WITH

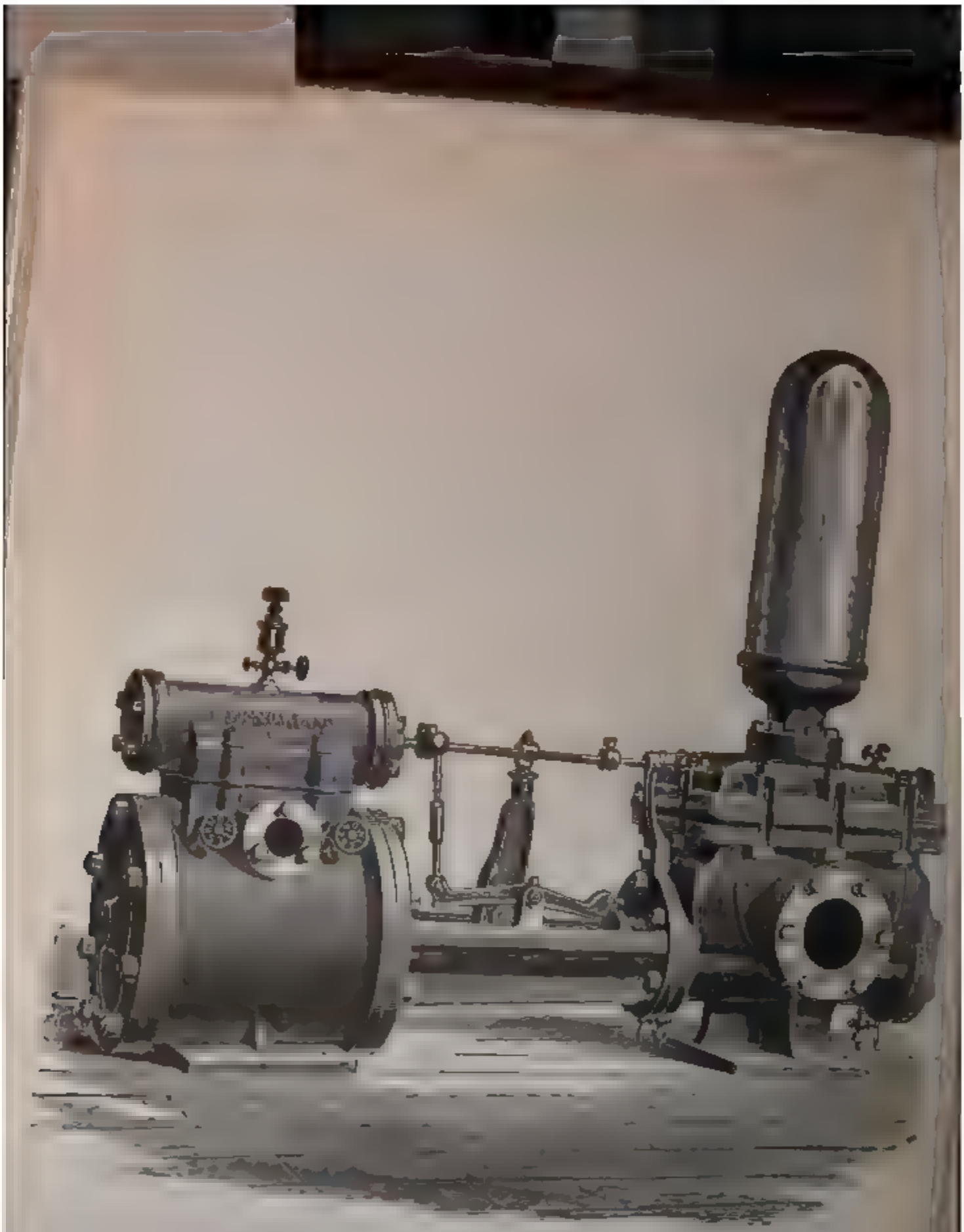
THE AUTOMATIC SPRINKLER SYSTEM,

now being so extensively introduced, affords the most complete protection to mills and manufacturing establishments that has ever been known.

This system is the locating of patent sprinkler heads or nozzles in different parts of the building; the caps of these heads are so sensitive that they are melted off at a low temperature of heat. This liberates the water, which is held in the pipes under pressure, and the fire is soon controlled if not entirely quenched

The pumps used in connection with this system are provided with our improved pressure regulators. This regulator is positively automatic in its action, and very sensitive, shutting off the steam and stopping the pump when the desired pressure has been reached, and again starting it on the slightest reduction of the pressure, thereby maintaining the desired pressure upon the pipes and sprinkler heads.

In relation to this system of protection, we would state that the Knowles Fire Pumps, both single and duplex patterns, have been accepted by the Manufacturers' Mutual Fire Insurance Companies for use automatically or otherwise in connection with the sprinklers.



KNOWLES PATENT MINING PUMP.

Regular Piston Pattern

KNOWLES PATENT

MINING PUMPS.

REGULAR PISTON PATTERN.

THE reputation of the Knowles Mining Pump, both at home and abroad, as the STANDARD pump for every class of mining work, has been well merited; it has always been recognized as the *best constructed* as well as the best designed pump in the market.

The duty to be performed by pumps in most mines is of necessity very severe and exacting. It is therefore an important requisite that pumps should be very durable, very simple, and at the same time *economical* in the use of steam. All these qualities are possessed in a marked degree by the

IMPROVED KNOWLES MINING PUMPS.

They require less attention and less repairs than any other make of pumping engines. They are the favorite mining pumps in the coal districts of Pennsylvania, where the worst water possible is pumped, and in the gold and silver mines of the Western States and Mexico, where the highest lifts are worked.

The new valve motion and general arrangement of the steam cylinders of these pumps have been brought to such a degree of perfection that they will work on the heaviest duty absolutely

WITHOUT SHOCK OR JAR ON PUMPS OR PIPES.

The engraving on the opposite page represents one of the Knowles Mining Pumps of the REGULAR PISTON PATTERN. This pump is adapted for ordinary work, where the water is usually free from grit and dirt, and not too strongly impregnated with sulphurous or other acids. The design of the pump shown is one of strength, compactness and durability. In these pumps the water cylinders have large valve areas and passages. The water valves are easy of access and can be readily removed and duplicated — like all the working parts of these pumps — with little trouble and expense in case of wear or accidental breakage. The linings, piston-rods, valve seats, valve bolts and other parts coming in contact with the mine water are made of the best gun-metal composition. The water pistons are also made of gun-metal composition and are packed with fibrous packing set out by adjustable set screws and nuts.

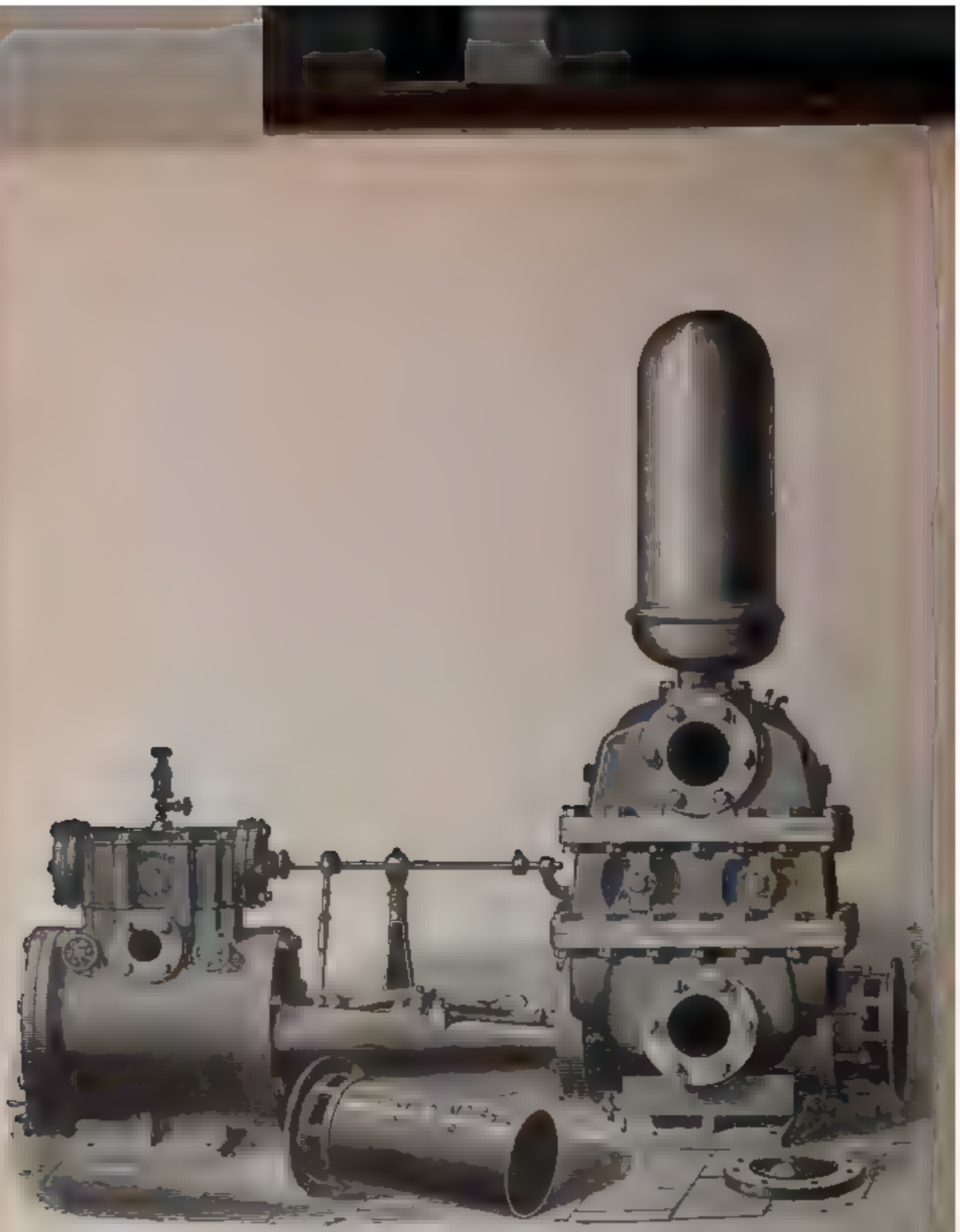
For full list of sizes and prices of these pumps, refer to page 27.

EVERY PUMP FULLY WARRANTED.

Piston Mining Pumps, arranged with *Patent Removable Cylinders*, see next two pages.

GUN-METAL COMPOSITION PUMPS.

There are many mines where the water is so impregnated with sulphurous or other acids as to require the pumps to be made with the water cylinders cast entirely of gun-metal composition. We have special patterns for this purpose, and only charge *the additional cost for the composition.*



KNOWLES PATENT MINING PUMP.

Removable Cylinder Pattern.

KNOWLES PATENT

MINING PUMPS—CONTINUED.

REMOVABLE CYLINDER PATTERN.

WHERE mine water is very gritty and it is found that the use of a *plunger* pump (the style of pump usually used for bad water) is prohibited on account of limited room or other adverse circumstances, a piston pump must be used. In order to secure the greatest possible durability with this form of pump, we arrange the water cylinder with our patent

UNIVERSAL REMOVABLE CYLINDER

or pump barrel, which can be easily taken out and replaced by a new one when necessity requires it.

This patent removable cylinder can be partially turned in the pump, so that as the bottom part is cut or worn (this is the point of usual wear) a new surface can be brought into position, and thus the wear distributed over every portion of the bore of the cylinder. Finally, after the removable cylinder has served its purpose fully, a new one can be readily substituted without interrupting the pumping over ten minutes' time

Another advantage of the *removable cylinder* feature is, that if it becomes necessary to place the pump lower in the mine—thus increasing the head to be pumped against—the original "REMOVABLE CYLINDER" can be changed for one of smaller bore, and so enable the pump to be continued in use.

The removable cylinder is a substantial casting of gun-metal composition, the design of which is shown in the opposite engraving. The valve-seats of the pump are independent plates of gun-metal composition; also the valve bolts, piston-rods, stuffing-boxes and water piston are made of gun-metal composition—this last being packed with patent fibrous packing set out by adjustable bolts and check nuts. The valves are of best vulcanized rubber or other material, and are easily reached by conveniently arranged hand-hole plates. The valve areas and water passages are large and free.

As the steam valves of the Knowles Mining Pumps are perfectly *positive*, they will always start on admission of steam—in fact, these

PUMPS WILL WORK UNDER WATER,

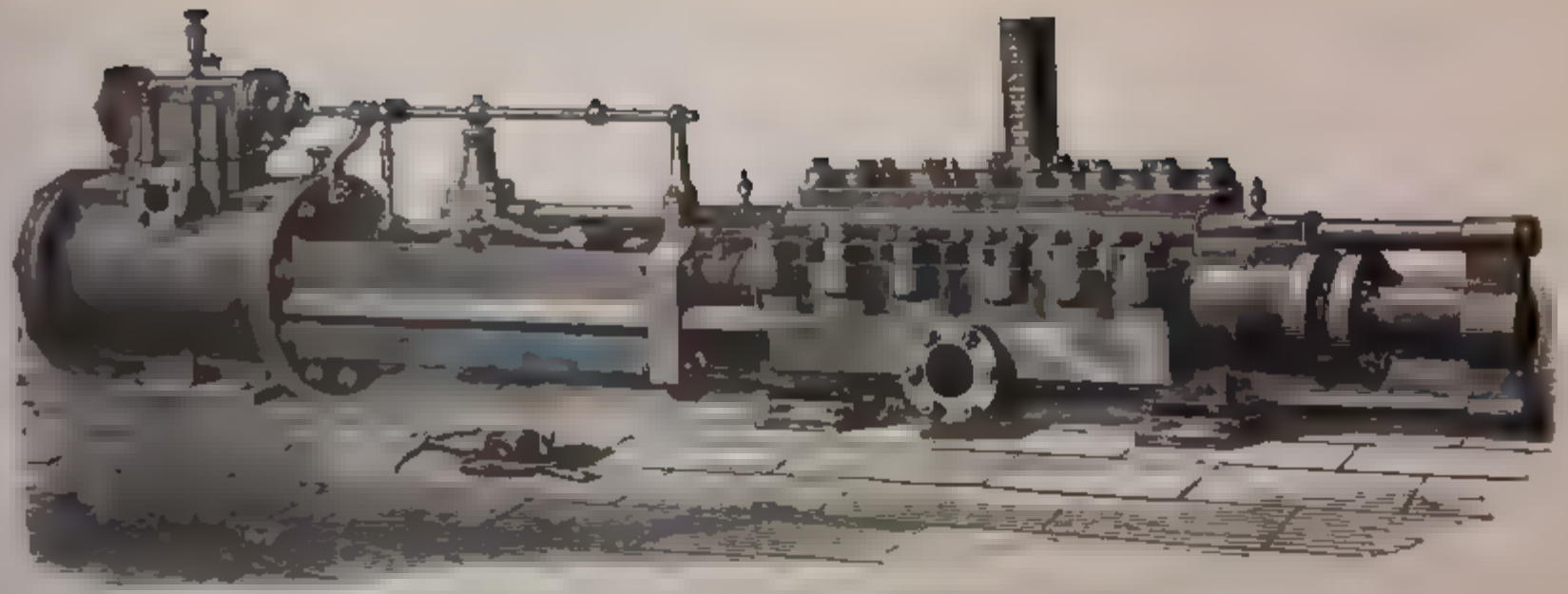
and clear themselves and the mine of water, whether steam, air or water is used in the steam cylinder. This is an important feature in case a mine becomes "drowned out."

Every pump before it is shipped from our factory is subjected to a rigorous test of hours' duration, under the heaviest pressure, consequently we are enabled to give a full guarantee with each and every pump sold.

☞ Sizes and prices of above REMOVABLE CYLINDER Piston Pumps will be found on page 27.

DOUBLE PLUNGER MINING PUMPS described on next two pages.

VERTICAL SINKING PUMPS, see pages 32 to 33-B.



KNOWLES PLUNGER MINING PUMP.

PATENT SOLID CYLINDER PATTERN

KNOWLES PLUNGER MINING PUMP.

KNOWLES PATENT
MINING PUMPS—CONTINUED.

DOUBLE-PLUNGER PATTERN.

PLUNGER pumps have always been held in high esteem by users of mining machinery, for they are the most satisfactory pumps, all things considered, especially where the water is bad and the pressure heavy. The Knowles Plunger Mining Pumps combine all the advantages of the best designs of this class of pumps, while they possess original features which place them in point of excellence beyond anything of the kind that is built in this or any other country.

FOR HEAVY DUTY, especially in coal mine work where the water is likely to be strongly impregnated with acid, we construct these pumps of the hardest iron it is possible to work, making the metal from *two to three inches thick*, and all water passages equal in area to the plungers. This form of pump, supplied with water valves of special form, working on seats made entirely of gun-metal composition, is almost indestructible in bad water. *These features will be appreciated by every mining engineer.*

In each of the engravings opposite it is shown that there are two single-acting plungers attached to strong cross-heads by heavy rods of wrought iron; these connecting-rods are supported by and slide on adjustable guides or bearings, thus keeping the plungers in line and preventing uneven wear. The piston-rod does not enter the pump cylinder, and is therefore not exposed to the action of the mine water. The plungers have outside stuffing-boxes which can be readily packed, and, being in sight, any leakage of water through the glands can be quickly detected. The plungers not passing through any sleeve or stuffing-box in center of cylinder, but being "outside connected," it is not possible for any water to leak by or to pass from one end of the cylinder to the other; the *displacement* of water at each stroke is exactly *equal*. The first engraving opposite represents

KNOWLES PATENT SOLID CYLINDER PATTERN.

This special form of mining pump is original with us and has many advantages not found in other forms of plunger pumps. It is especially adapted for the heaviest work, and will pump in a single lift of 1000 feet as well as one of 300 feet high.

The heavy castings, absence of joints and peculiar arrangement of valves and plungers, render this pump *exceedingly* durable. Practically, the only wearing point in the entire water end is the packing in the stuffing-boxes. It is provided with two hand-hole plates, so that the cylinder can readily be cleaned.

The lower engraving opposite represents

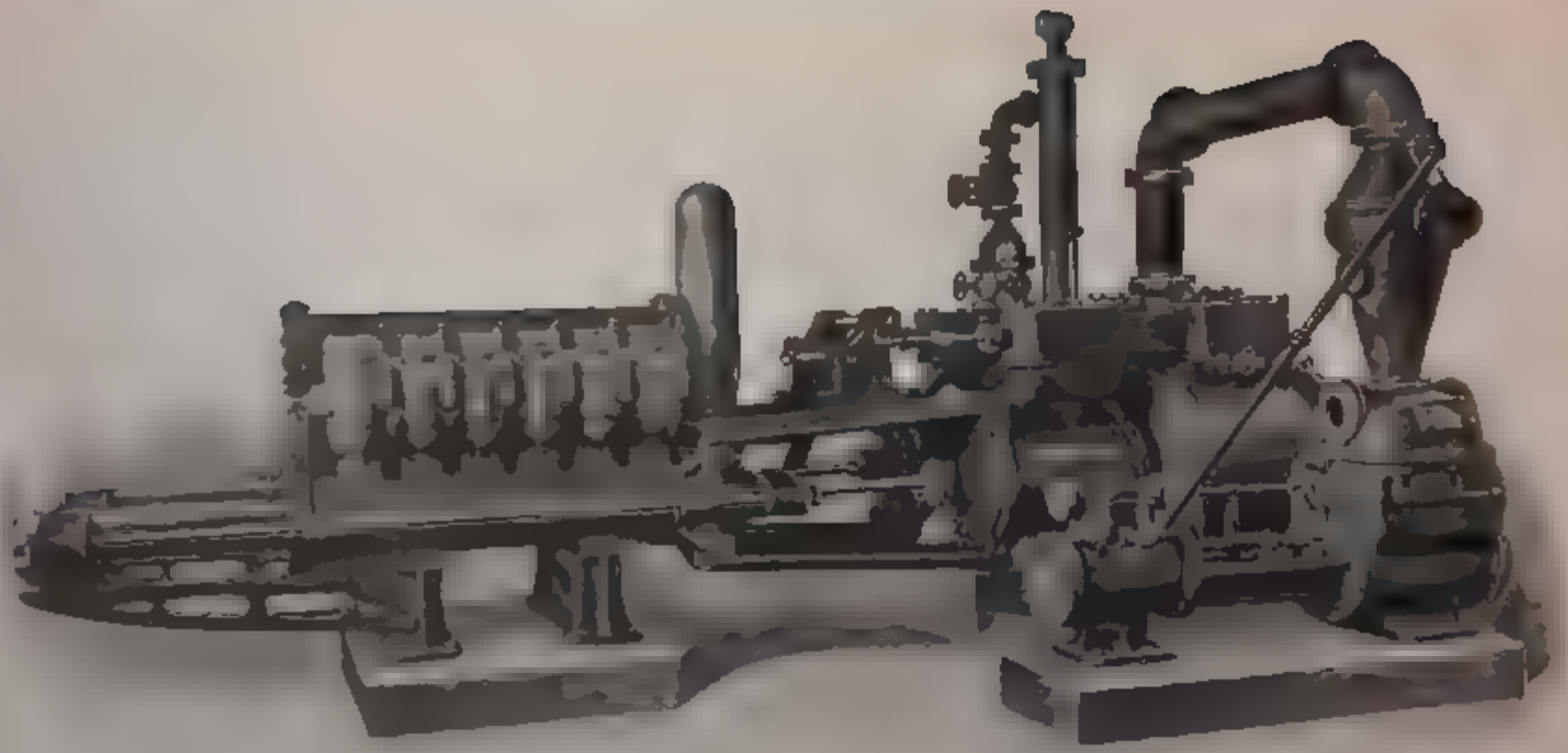
KNOWLES PATENT "POT-VALVE" PATTERN.

This form of mining pump differs from the above only in the arrangement of water valves, which (as the engraving shows) are enclosed in heavy "pots." These valves are of special design (patented) and possess the double advantage of quiet action and great durability. The valves work on *gun-metal composition seats;* the valves and seats can be readily taken out in one movement after the covers of the "pots" are removed. The "Pot-Valve" form of mining pumps is one that has long been popular with old mining engineers.

We have complete patterns for every size of both of the above styles of Improved Plunger Mining Pumps. See list of sizes and prices on next two pages. Prices on Pot Valve Pumps on application.

Compound Condensing *Plunger* Mining Pumps, see pages 28 and 29.

VERTICAL *Plunger* Sinking Pumps, see pages 33-A and 33-B.



KNOWLES "SPECIAL" COMPOUND CONDENSING DUPLEX MINING PUMP.

Size [illegible] x [illegible] x 24

With Independent Air Pump and Condenser

For description see page 20.

KNOWLES PATENT
MINING PUMPS—CONTINUED.

TABLE OF SIZES.

OUR experience in building pumps for mines in all parts of the world has proved that no one form of pumping engine can fully meet the requirements of mines in different sections, or of those in the same locality working under different conditions. Consequently we have, at great expense, designed and constructed the several different styles, which we fully describe in this catalogue, believing that THEY FULLY COVER THE REQUIREMENTS of the various mines.

The table below gives the principal sizes of the three standard types of our Horizontal Mining Pumps, viz.:
REGULAR PISTON PATTERN, as described on pages 20 and 21.
REMOVABLE CYLINDER PATTERN, as described on pages 22 and 23.
DOUBLE PLUNGER PATTERN, as described on pages 24 and 25.

SIZES AND CAPACITIES.

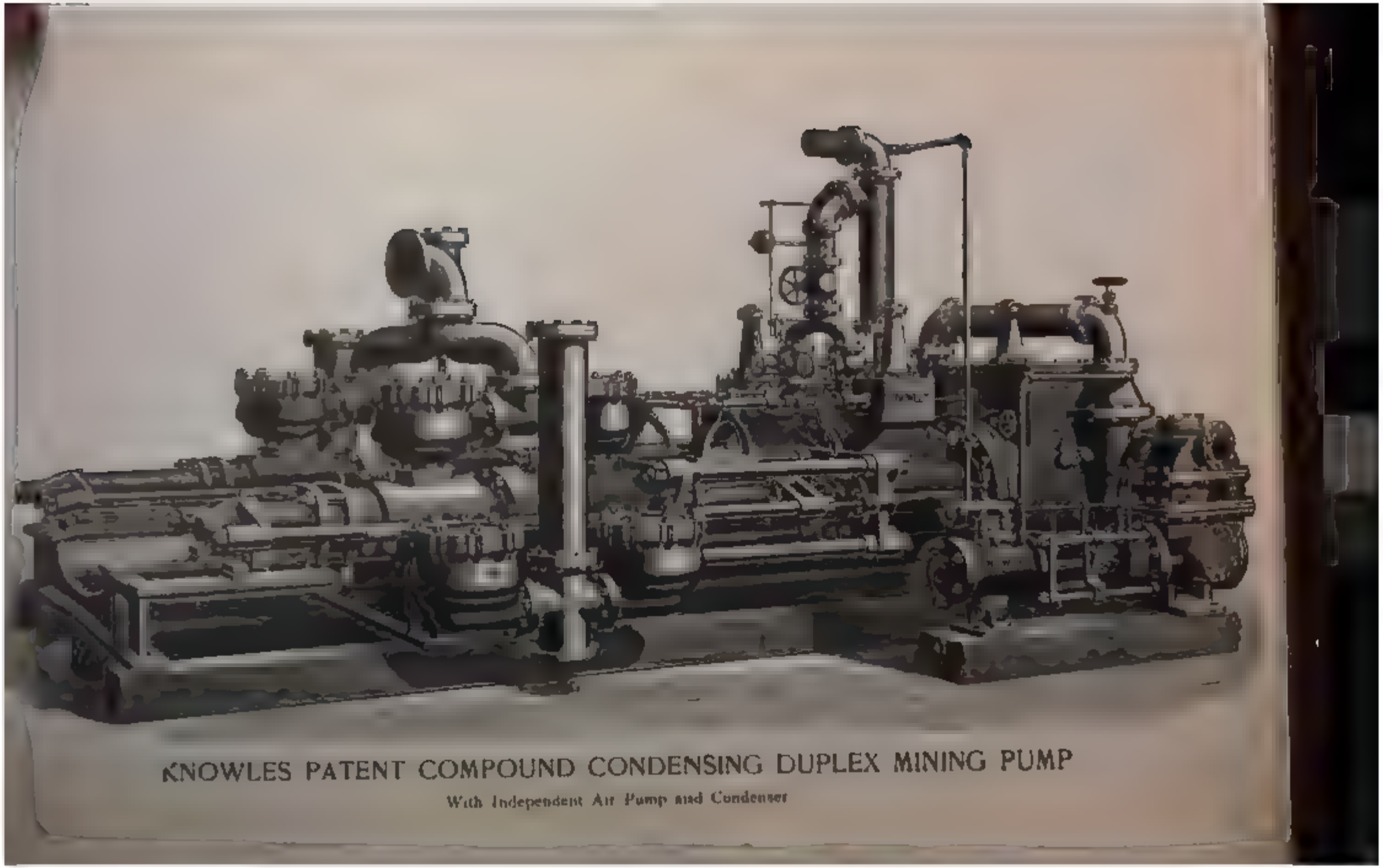
Steam Cylinder	Water Cylinder or Plungers.	Stroke	Gallons per Stroke.	Capacity per Minute at Ordinary Speed.		Steam Pipe.	Exhaust Pipe.	Suction Pipe.	Delivery Pipe.
Inches.	Inches.	Inches.				Inches.	Inches.	Inches.	Inches.
6	3	7	.22	125 Strokes,	28 Gallons	¾	1	2	1¾
6	3¼	7	.34	125 "	42 "	¾	1	2	1¾
7½	3¼	10	.36	100 "	36 "	1	1¼	2	1½
7½	3¼	10	.47	100 "	47 "	1	1¼	2½	2
7½	4½	10	.69	100 "	69 "	1	1¼	3	2½
8	4	12	.65	100 "	65 "	1	1¼	3	2½
8	4½	12	.82	100 "	83 "	1	1¼	3	2½
8	5	10	.85	100 "	85 "	1	1¼	3	2½
8	5	12	1.02	100 "	102 "	1	1¼	4	4
10	4	12	.65	100 "	65 "	1¼	1½	4	4
10	4½	12	.82	100 "	82 "	1¼	1½	4	4
10	5	12	1.02	100 "	102 "	1¼	1½	4	4
10	6	12	1.47	100 "	147 "	1¼	1½	4	4
12	5	12	1.02	100 "	102 "	2	2½	4	4
12	6	12	1.47	100 "	147 "	2	2½	4	4
12	7	12	2.00	100 "	200 "	2	2½	5	5
12	8	12	2.61	100 "	261 "	2	2½	5	5
14	5	12	1.02	100 "	102 "	2½	3	4	4
14	6	12	1.47	100 "	147 "	2½	3	4	4
14	7	12	2.00	100 "	200 "	2½	3	5	5
14	7	16	2.67	75 "	200 "	2½	3	5	5
14	8	12	2.61	100 "	261 "	2½	3	5	5
14	8	16	3.48	75 "	261 "	2½	3	5	5
16	7	16	2.67	75 "	200 "	2½	3	5	5
16	7	24	4.00	50 "	200 "	2½	3	5	5
16	8	16	3.48	75 "	263 "	2½	3	5	5
16	8	24	5.22	50 "	263 "	2½	3	5	5
16	9	16	4.44	75 "	332 "	2½	3	6	6
16	9	24	6.60	50 "	332 "	2½	3	6	6
16	10	16	5.33	75 "	410 "	2½	3	6	6
16	10	24	8.16	50 "	410 "	2½	3	10	8
18	8	16	3.48	75 "	263 "	2½	3	5	5
18	8	24	5.22	50 "	263 "	3½	4	5	5
18	9	16	4.44	75 "	332 "	2½	3	6	6
18	9	24	6.60	50 "	332 "	3½	4	6	6

ALSO PATTERNS FOR LARGER SIZES AND OTHER COMBINATIONS OF CYLINDERS

In ordering, purchasers should be specific in giving information as to the conditions under which the pumps are to operate, that we may be able to do full justice to ourselves and give entire satisfaction. They should also state whether the water is clear or gritty, and particularly if it is impregnated with sulphurous or other corroding acids. If it is necessary to arrange the pumps with

GUN-METAL COMPOSITION WATER CYLINDERS

we have special patterns for this purpose, charging only for the additional cost of the composition metal.



KNOWLES PATENT COMPOUND CONDENSING DUPLEX MINING PUMP

With Independent Air Pump and Condenser

KNOWLES PATENT

MINING PUMPS—CONTINUED.

COMPOUND CONDENSING DUPLEX PLUNGER PUMPS.

With Independent Air Pump and Condenser.

WE are furnishing many of the deep mines of this country and Mexico with the Knowles Improved Compound Condensing Plunger Mining Pumps, complete with Independent Air Pumps and Condensers. This improved type of direct-acting pumping machinery is becoming very popular among mining engineers, as the greatest simplicity and efficiency are combined with

HIGHEST ECONOMY IN USE OF FUEL.

Like the best types of modern (compound) steam engines, these improved pumping engines are arranged with high and low pressure steam cylinders—the steam, after being used in the former, is expanded into the latter, and utilized a second time before it goes to the condenser. The Independent Air Pump is compact and very efficient, giving the highest vacuum desired. The injection water for the condenser is drawn from the "sump" or tank, from which the main pump takes its supply. The warm water discharged by the air pump is carried to a point close to the suction pipe of the main pump.

Briefly stated, the Knowles Compound Condensing Plunger Mine Pumps possess the following advantages over the more cumbersome and complicated "Cornish" or Rotative pumping engines, viz.:

a.—The first cost is from 30 to 50 per cent less.

b.—In transportation and in erection the expense is less than half.

c.—Do not require massive and expensive foundations or large buildings.

d.—There are no pump rods, guides, rollers, "bobs" or other parts to produce excessive friction, get out of order and wear out.

e.—Require less attendance, as there are so few working parts; also require less expense for oil, waste and similar supplies. Take up considerably less of the room in the shaft.

f.—As they are double-acting in operation, the column of water is kept continually in motion, thereby relieving pipes and pumps from *shock and jar*, and avoiding leaky joints in column pipe.

g.—Smaller column pipes can be used, as the water is not intermittent in its flow, consequently the outlay for column pipe is very much less—an important item of saving.

h.—Can pump the water in lifts of greater height, as it is only necessary to proportion the power of the steam cylinders to the load on the water plungers. (We have many of these pumps pumping as high as 1000 feet vertically in *one* lift.)

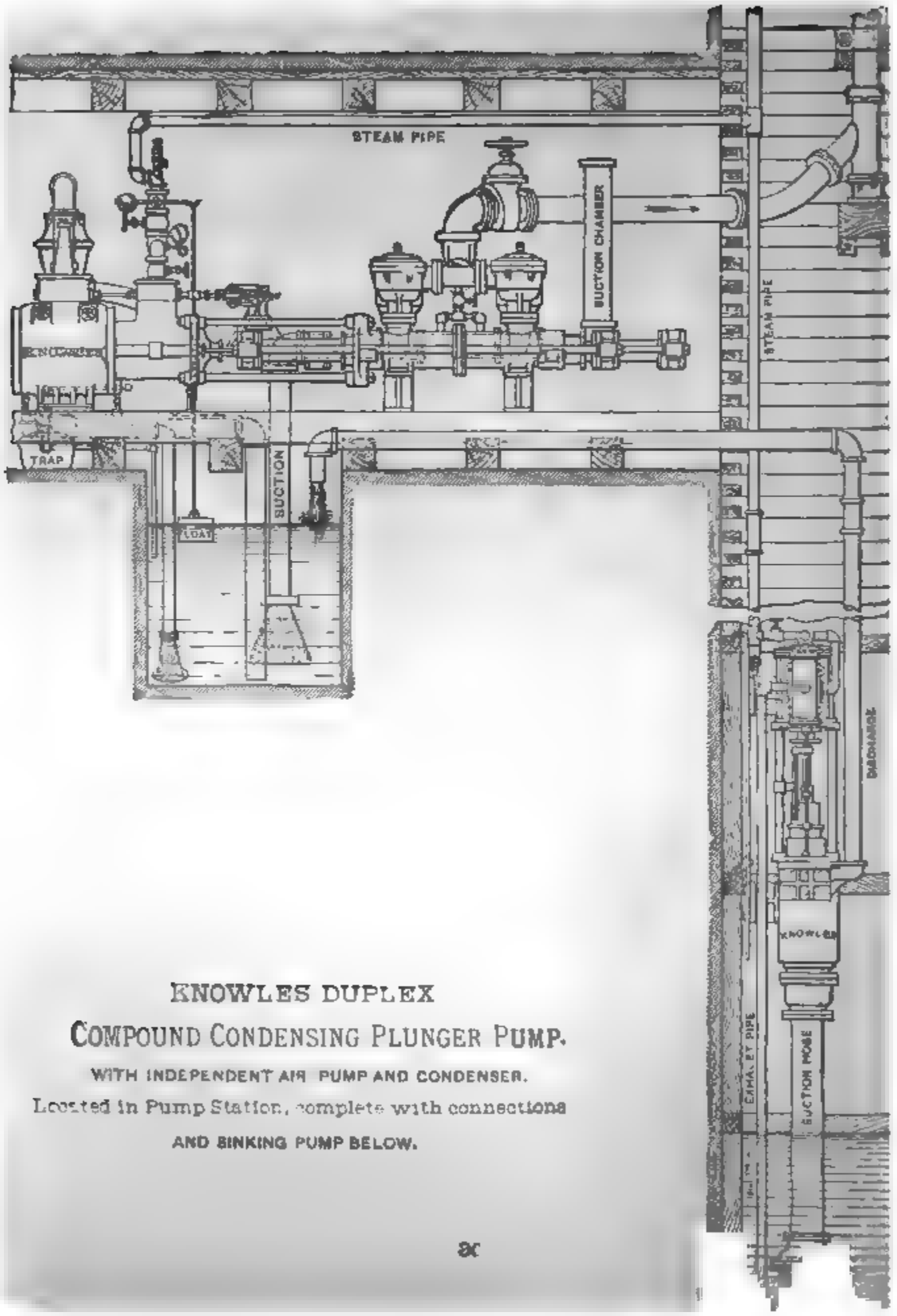
The engraving on opposite page illustrates one of these Compound Condensing Mining Pumps, having a capacity of about 900 gallons per minute and of sufficient power and strength to elevate the water in one lift 1000 feet in height. These pumps are made with the water cylinders and valves arranged like either of the designs shown on page 24. They are built exceedingly strong and compact, and are

FULLY GUARANTEED TO GIVE SATISFACTION.

Estimates and further particulars on application.

These COMPOUND MINING PUMPS also built on SINGLE System, when preferred.

☞ Send for Special Catalogue giving full particulars of every class of Knowles Mining Pumps.



KNOWLES DUPLEX

COMPOUND CONDENSING PLUNGER PUMP.

WITH INDEPENDENT AIR PUMP AND CONDENSER.

Located in Pump Station, complete with connections

AND SINKING PUMP BELOW.

or

KNOWLES PATENT
MINING PUMPS—CONTINUED.

COMPOUND CONDENSING DUPLEX PLUNGER PUMP

WITH INDEPENDENT AIR PUMP AND CONDENSER,

LOCATED IN PUMP STATION, COMPLETE WITH CONNECTIONS, WITH SINKING PUMP BELOW.

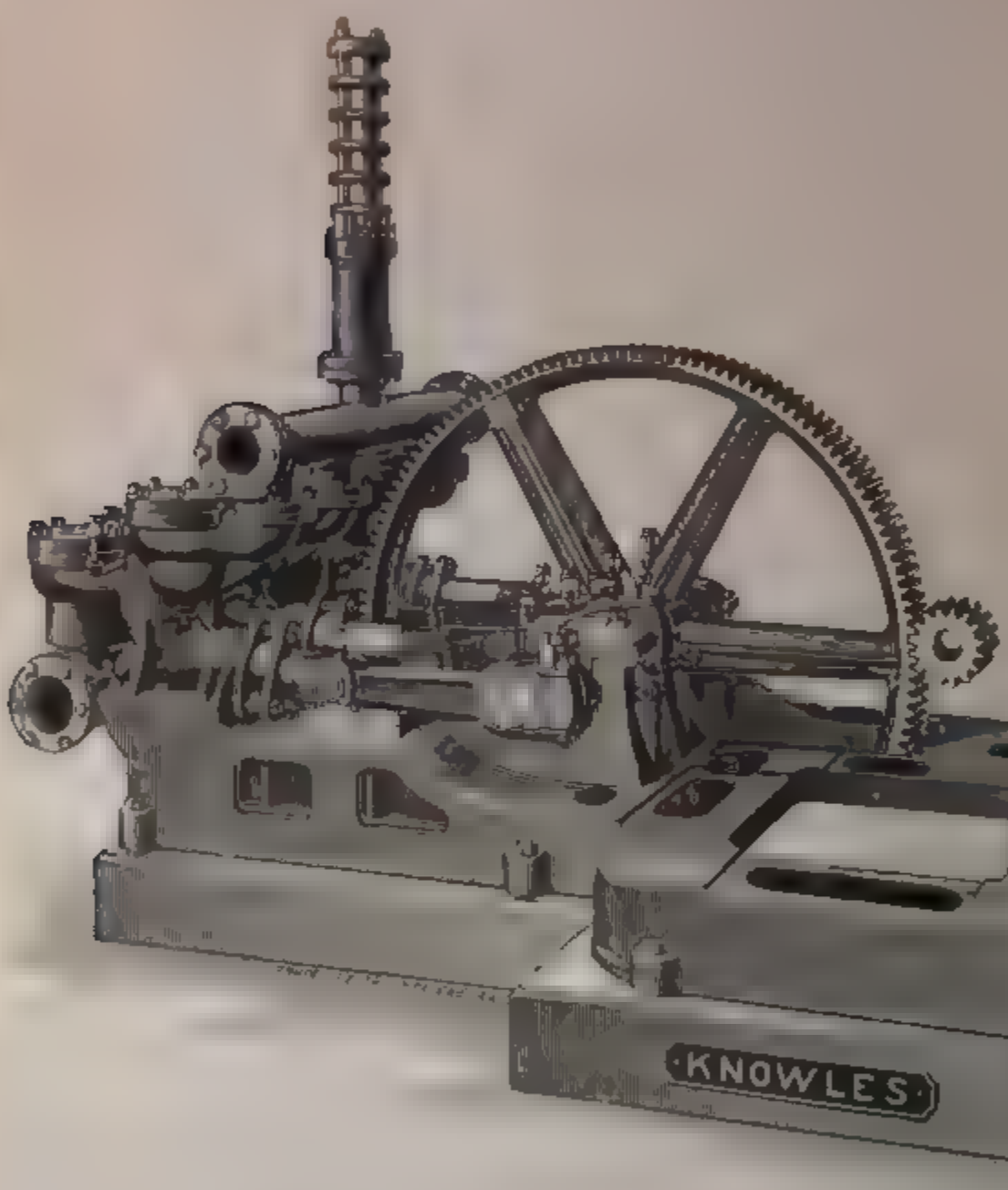
THE cut on opposite page is from a drawing representing the 600 foot pump station of a mine, with the Knowles Compound Condensing Duplex Pumping Engine in place, and the Sinking Pump in position below the station. This pumping engine is fully described on the preceeding pages, i.e. pages 28 and 29. The Vertical Sinking Pump is shown and described on pages 32 to 33-B.

In deepening the shaft the Sinking Pump is lowered at intervals as the excavation progresses. The water at the bottom of the shaft is taken by the sinking pump and delivered to the tank or sump that supplies the pumping engine in the station. A single steam pipe down the shaft supplies both the pumping engine and sinking pump. The exhaust steam from the pumping engine, as before explained, is condensed by the Independent Air Pump and Jet Condenser. The exhaust steam from the sinking pump, however, is usually carried to the sump or into a special connection arranged on the suction nozzle of the sinking pump. This connection is a neat and inexpensive condensing arrangement (not shown in the cut) and does away with the exhaust steam-pipe in the shaft.

With a pumping plant similar to that described, mines can be sunk to any depth desired, or flooded mines recovered with the greatest facility and security. For mines of extreme depth it has been found advisable to put pumping stations, similar to that shown on page 30, at every 500 to 600 feet distant apart, although this distance can be increased to 800 or 1,000 feet, when desired. By this system, the Compound Condensing Pumping Engine in the lower station delivers to the next above (which is a duplicate of same) and so on to the surface. Below the lowest pump station is placed the sinking pump, as referred to above. Generally these sinking pumps are duplicated, for convenience and security. A mine thus equipped has the most reliable, simple, economical and complete pumping machinery known in modern mining practice.

The cut opposite is taken from drawings of pumps in actual work, to which further reference will be gladly given when desired.

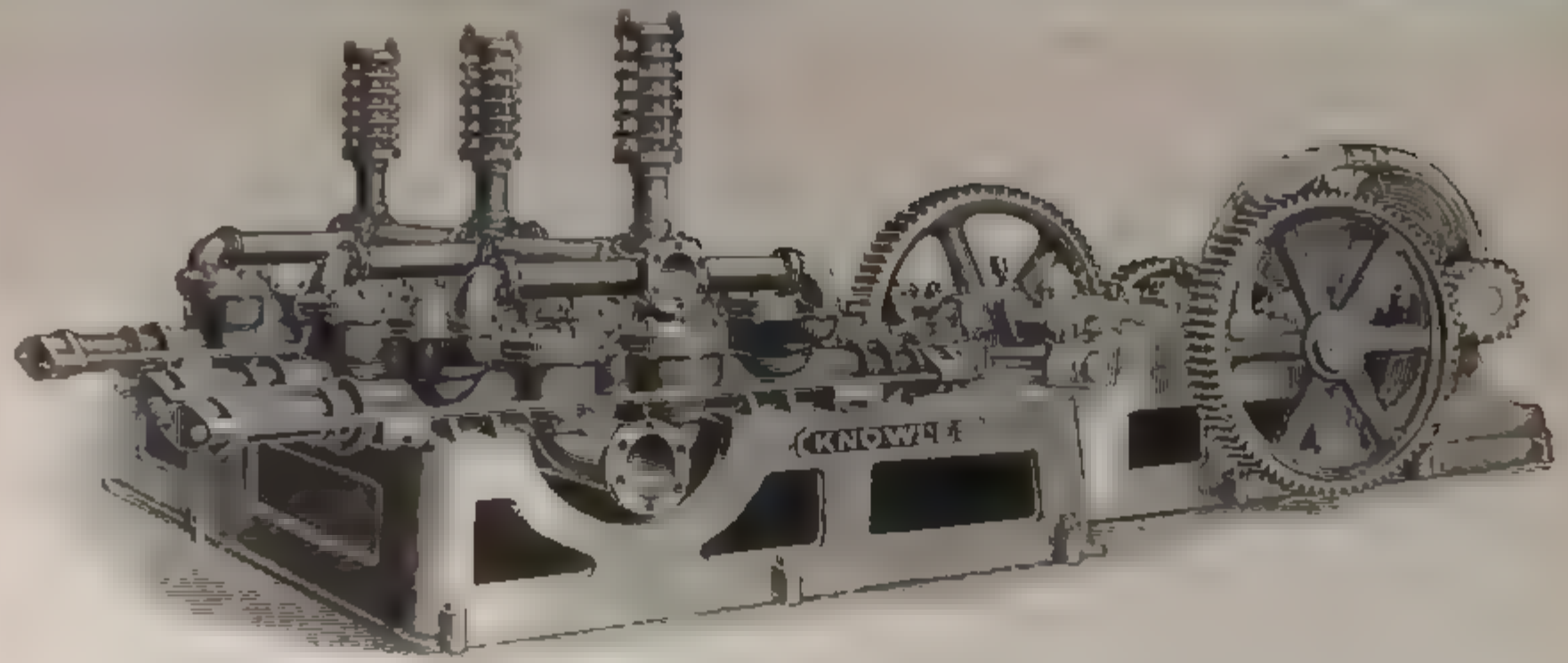
Estimates, plans and full particulars on application. Send for special Mining Catalogue.



HORIZONTAL TRIPLEX ELECTRIC POWER PUMP.

With Single Acting Outside Packed Plungers.

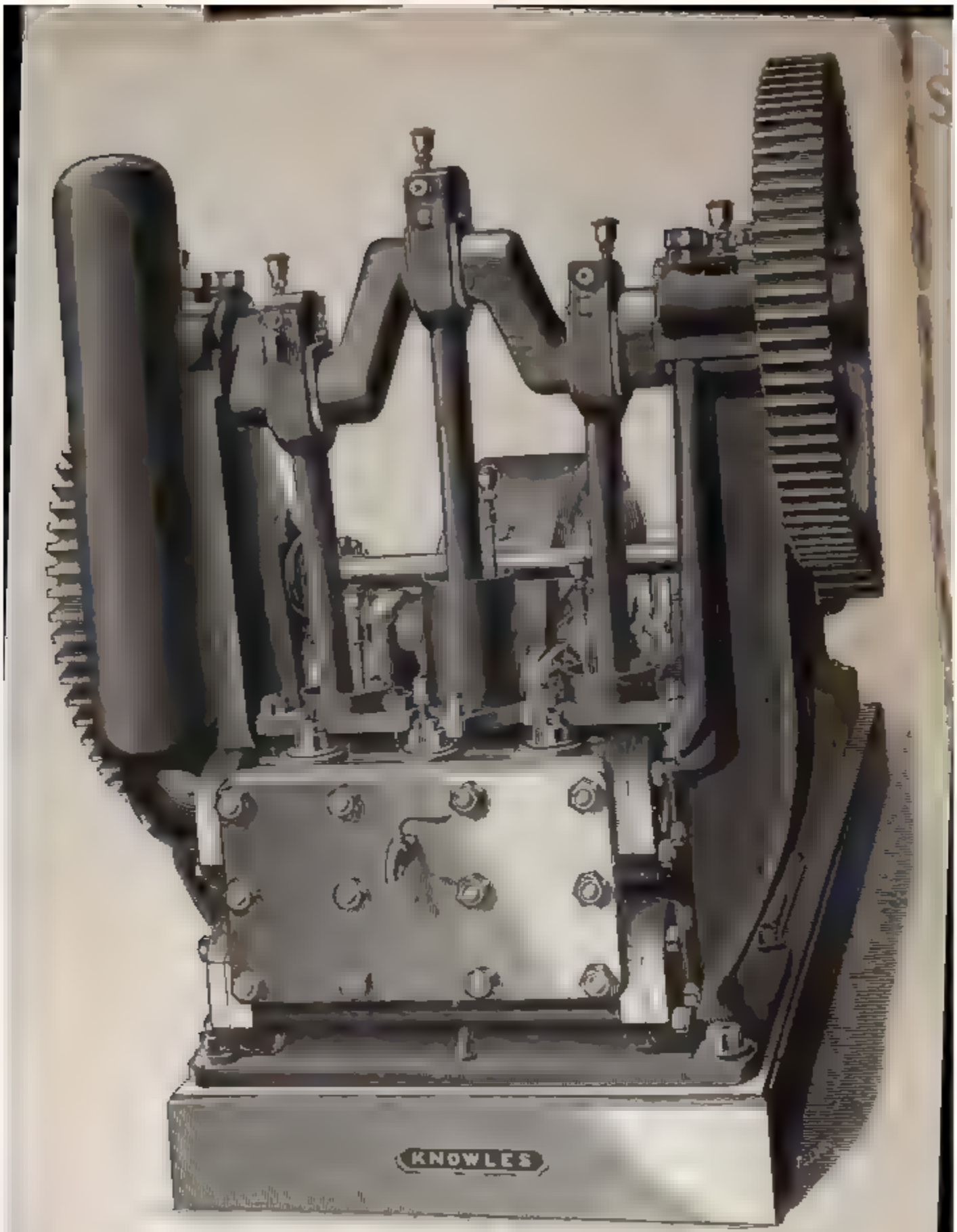
Prices on application Send full particulars of work pumps will be required to perform as it is much better to have Electric Pumps built expressly for the work they are to do. Send for Special Catalogue of Electrically Operated Power Pumps.



HORIZONTAL TRIPLEX ELECTRIC POWER PUMP.

With Double Acting Outside Packed Pungers

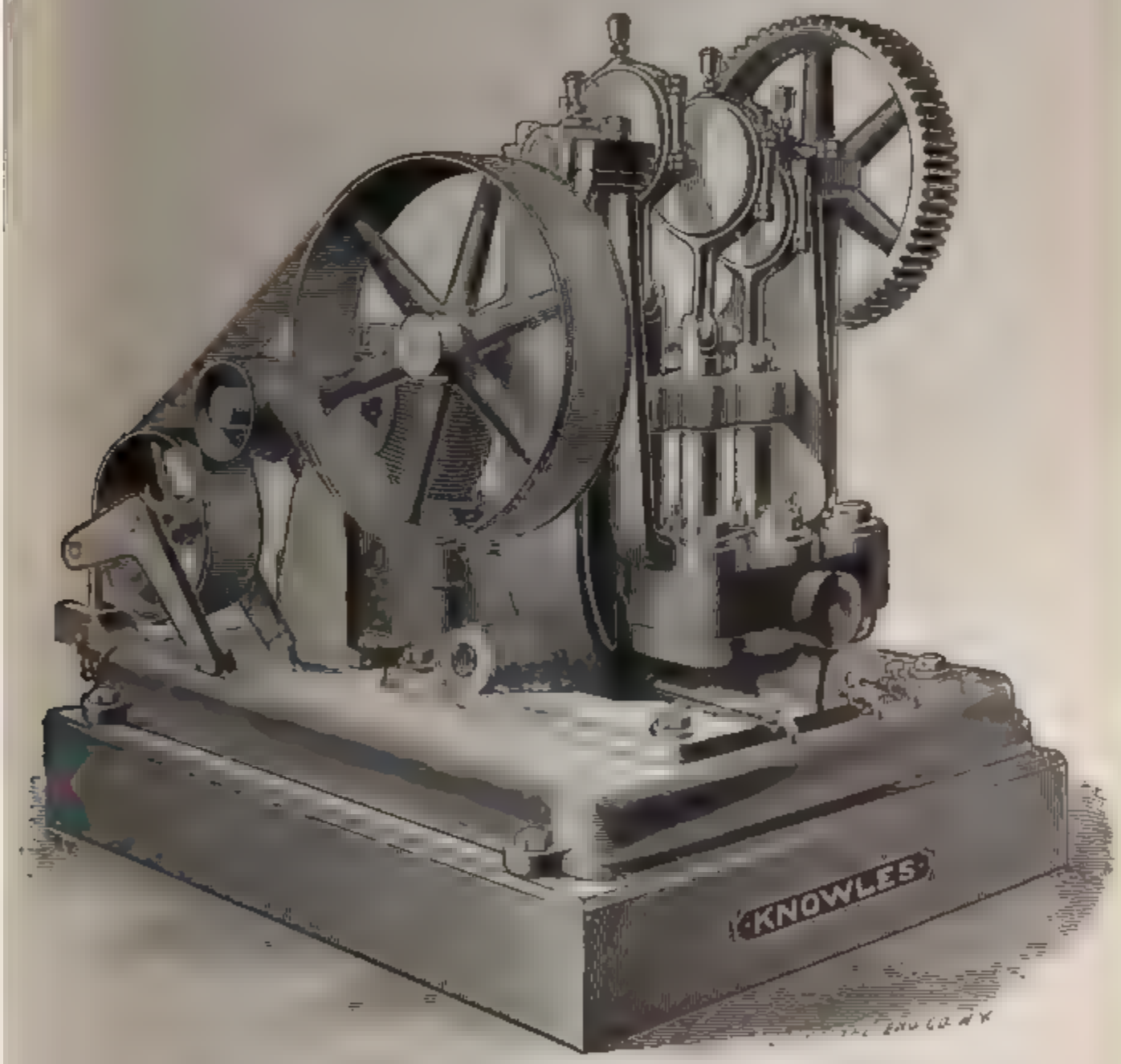
Prices on application. Send full particulars of work pumps will be required to perform—it is much better to have Electric Pumps built expressly for the work they are to do. Send for Spec a Catalogue of Electrically Operated Power Pumps



KNOWLES VERTICAL TRIPLEX POWER PUMP.

Geared directly to motor mounted on extension base.
Send for special catalogue of Electrically Operated Power Pumps.

Special Belt Driven Vertical Triplex Electric Power Pump.



THIS illustration shows one of the smaller sizes of vertical triplex pumps with extended bed plate for electric motor, but connected by a special form of belt transmission instead of gearing as in the ordinary pattern

While not mechanically so efficient a device as a pair of machine-cut gears, this arrangement combines the noiselessness of a belted power pump with extreme compactness, making it a very desirable form for house, hotel and public building service.

Send for special catalogue of Electrically Operated Power Pumps.

KNOWLES PATENT VERTICAL SINKING PUMP.

KNOWLES PATENT

VERTICAL SINKING PUMP.

"BUCKET AND PLUNGER" PATTERN.

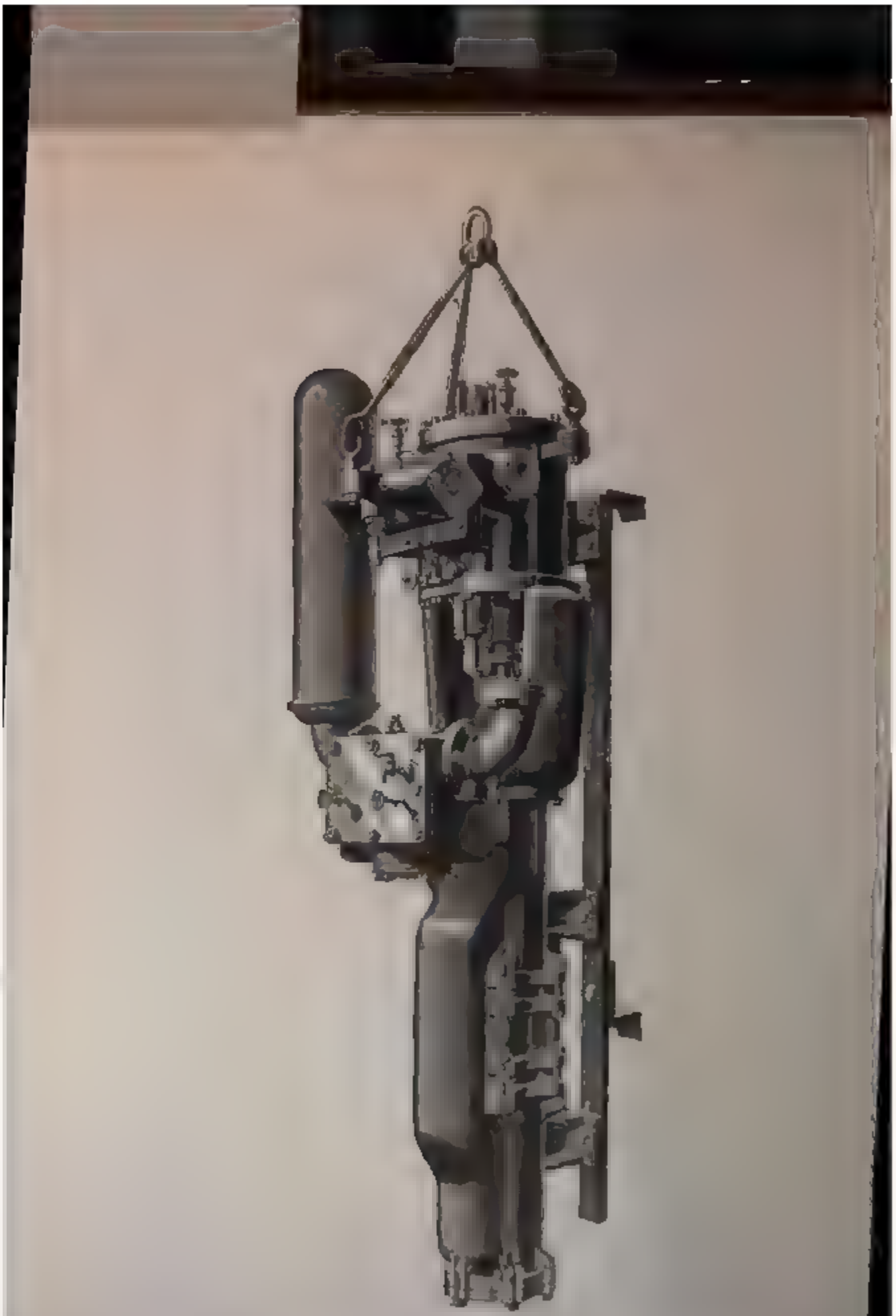
THIS improved type of sinking pump is especially adapted for sinking new shafts, recovering "drowned-out" mines, and for general excavating work involving a variable water level. It is compact, easily handled, and, while designed to work in a vertical position, will operate satisfactorily at any desired angle, either suspended by a tackle or hooked to the shaft timbering. It is positive in operation, throws a steady, continuous stream of water, and owing to the improved form of valve motion, and a special cushioning device in the steam cylinder, is exceedingly quiet in action.

The lower plunger, or "bucket," works in a *removable* cylinder of hard iron, which may be replaced readily and at slight expense when worn out

Swing bolts allow of easy access to the pump barrel and valves, the latter being of best vulcanized rubber, with gun-metal seats. The suction opening is at the lower end, convenient for attaching hose or piping, the discharge nozzle being above and to one side of the water cylinder. Each pump is fitted with a ring bolt, firmly imbedded in the cylinder head, for hanging by tackle, and with adjustable wrought-iron dogs bolted to cylinders, for hanging from shaft timbers.

Diameter of Steam Cylinder	Diameter of Lower Plunger	Diameter of Upper Plunger	Stroke	Gallons per Stroke	*Capacity per Minute Gallons	Steam Pipe	Exhaust Pipe	Suction Pipe	Discharge Pipe	Dimensions over all	Weight	Code Word.
6	5⅜	3¾	10	.48	40	¾		3½	2	70 x 18 x 13	745	Aneurism
8	5⅜	3¾	10	.48	40		1¼	3½	2	71 x 18 x 13	935	Anexabasis
8	6⅜	4½	10	.69	80		1¼	4	2½	72 x 22 x 15	1080	Anexadore
10	7	5	10	.85	100	1¼	1½	4	3	72 x 22 x 15	1150	Anexaisa
12	8½	6	12	1.47	150		2½	5	4	80 x 24 x 17	2510	Anexamort
12	10	7	16	2.66	200		2½	6	5	114 x 29 x 22	2900	Anexanas
14	10	7	16	2.66	200		3½	6	5	114 x 29 x 22	3040	Anexarse
16	10	7	16	2.66	200	3½	3	6	5	115 x 29 x 23	3325	Anexaroni
16	12	8½	16	3.92	300	2½	3	8	6	115 x 30 x 23	5005	Anexasten
18	12	8½	16	3.92	300	2½	3	8	6	116 x 31 x 24	5150	Anexidades
18	14	10	24	8.16	400	3½	4	10	6	152 x 40 x 30	6535	Anexim
20	14	10	24	8.16	400	3½	4	10	6	152 x 40 x 30	7430	Anfacheln

*Capacities given are for a piston speed of about 100 feet per minute. This may be doubled in an emergency, but we do not recommend exceeding it for continuous service



SPECIAL VERTICAL PLUNGER SINKING PUMP

33—A

KNOWLES PATENT

VERTICAL SINKING PUMP.

Outside Packed Plunger Pattern.

IN this type of pump a hard iron plunger moves in two working-barrels having stuffing boxes and glands fitted with swing bolts for convenience in packing. The valves are of medium hard rubber, with brass seats, bolts and springs, the valve chamber being independent and easily removable for inspection or repairs. The suction valve chamber is fitted with automatic air valves for relieving the pump of air, and the discharge air chamber has a cock for the same purpose. The discharge elbow is fitted with a standard flange and has a cock for drawing off the water in discharge pipe when desired. The bottom flange of the lower working barrel has swing bolts for convenience of removal in order to take out sand or gravel, and the discharge air chamber is in one piece, securing compactness and minimum weight.

The steam cylinder has a recently improved valve gear, without external moving parts, thus reducing the liability to injury from accident or rough usage. The entire design of this pump is exceptionally strong and compact; workmanship and materials are of the best, and fully warranted in every respect.

Diameter of Steam Cylinder	Diameter of Plungers	Stroke	Gallons per Stroke	*Capacity per Minute Gallons	Steam Pipe.	Exhaust Pipe.	Suction Pipe	Discharge Pipe	Dimensions over all	Weight	Code Word.
7	3½	12	.50	50	1	1½	2½	2	74 x 25 x 27 5/8	1100	Jobation
8	4	12	.65	65	1	1½	3½	2½	74 x 25 x 27 5/8	1200	Jobber
8	4½	12	.86	80	1	1½	4	3	83¼ x 25 x 31¼	1200	Jockey
10	3¾	12	.55	55	1½	2	3½	2½	86 x 28⅞ x 27 5/8	1450	Jocund
10	4½	13	.89	85	1½	2	4	3	88 x 28⅞ x 31¼	1800	Joist
10	5	13	1.10	100	1½	2	4	3	88 x 28⅞ x 31¼	1900	Joker
12	■	13	1.59	150	1½	2½	5	4	98 x 32⅛ x 30⅝	2450	Jolly
12	7	14	2.33	200	1½	2½	5	4	108 x 34⅝ x 30⅝	3500	Jolted
14	7	14	2.33	200	2	3	5	4	112⅜ x 35⅜ x 30⅜	4150	Jostle
16	■	16	3.48	260	2½	4	6	5	124 x 44 x 43	4700	Jostrel
18	9	16	4.41	330	3	4	6	5	126 x 46 x 45	6500	Jotbar
16	11	20	8.23	500	3	5	8	7	176¼ x 40⅜ x 38½	10800	Jovak
16 †	12	20	9.79	600	3	5	8	7	176¼ x 40⅜ x 38½	10800	Jowty

*** Capacities given are for a piston speed of about 100 feet per minute. This may be doubled in an emergency, but we do not recommend exceeding it for continuous service.**

† These pumps have two steam cylinders placed tandem on the same rod, and taking steam at full pressure. Send for circulars of the Palmer Special Sinker.

Special Wrought-Iron Column Pipe.

THIS pipe is made of a superior quality of lap welded wrought iron, with patent cast iron lugged flanges and furnished complete with bolts, nuts and gaskets. It comes in all sizes from 6 inches to 15 inches, outside diameter cut to specific length not exceeding 15 feet. The flanges are shrunk or expanded and beaded; they are also faced off and counter-bored, with male and female joints. With this arrangement it is impossible for the gaskets to blow out. This pipe is tested to 600 pounds per square inch; consequently it has the advantage of great strength, yet it is much lighter than any other form of pipe, which makes a great saving in freight and handling. Further particulars and prices furnished on application.

Suction Hose and Connections.

THIS Suction Hose is adapted especially for mining work, and is of a superior quality of vulcanized rubber, made on spirally wound flat galvanized iron. The couplings at each end are plain flanges for bolting to the suction nozzle of pump and to the flanges of the strainer. This hose comes in all sizes, from two to ten inches.

EXPANSION JOINT FOR STEAM PIPE.

PRICES ON APPLICATION.

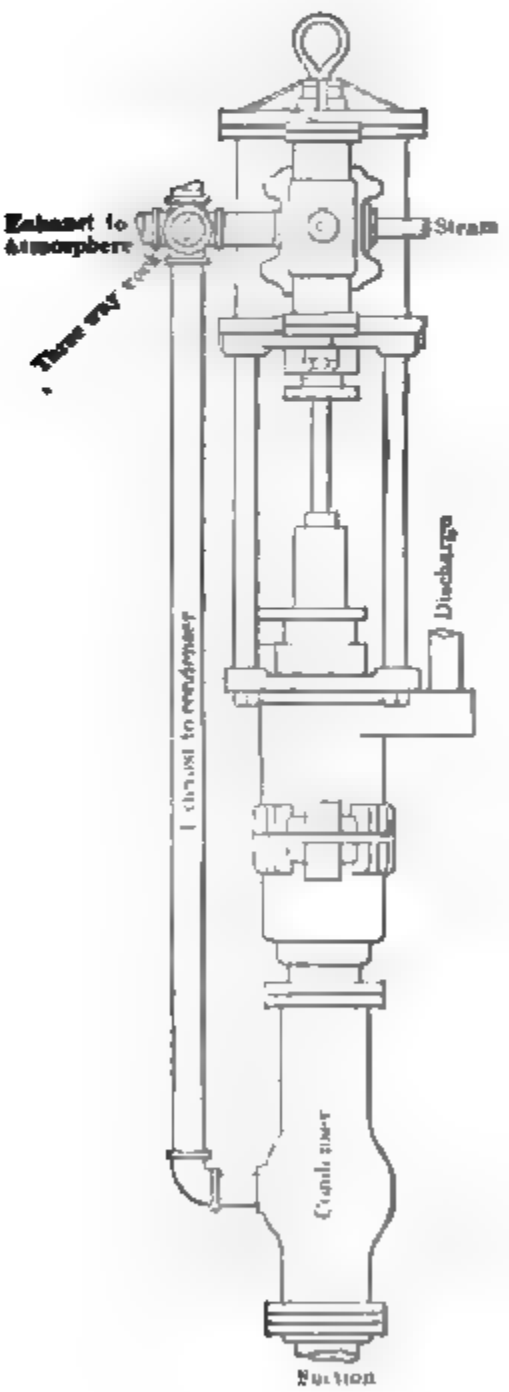
[redacted]

KNOWLES IMPROVED

SUCTION CONDENSER.

For Sinking Pumps.

THE accompanying diagram shows the general arrangement and connections of our Patent Suction Condenser, which may be bolted directly to the suction end of any of our Mine Sinking Pumps.

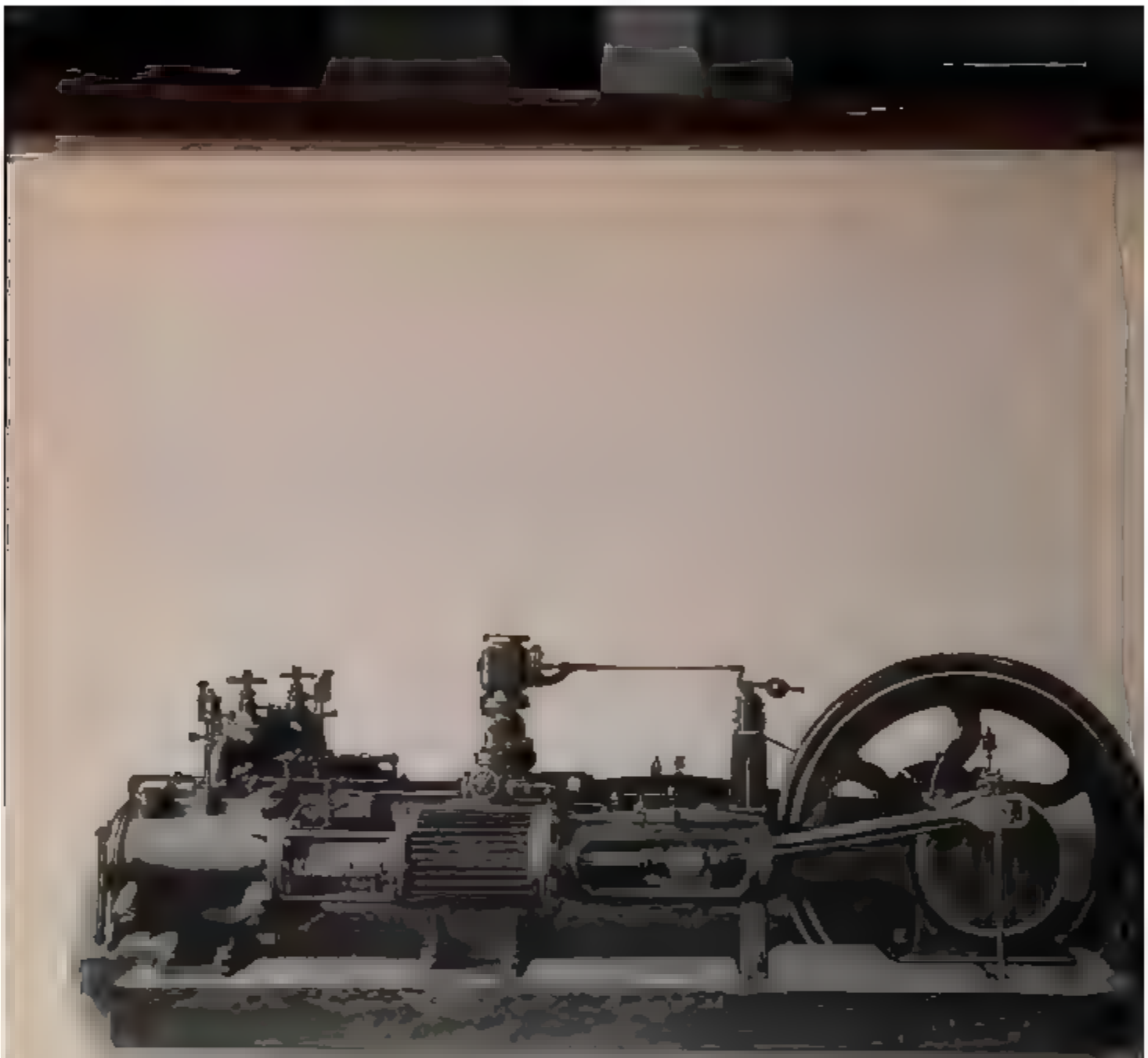


A three way cock is used with this apparatus, allowing the steam to exhaust into the atmosphere when the pump is first started, and passing it to the condenser when the pump has taken its water and is making full stroke. The construction is extremely compact and efficient, the exhaust being received in an annular space surrounding the suction column, and the water of condensation withdrawn by an ejector action due to its flow

Sizes given in table are standard for our own pumps, others built to order at short notice.

*SIZE	WEIGHT	PRICE	CODE WORD.
2½	210		Jabber
3	240		Jackal
3½	300		Jackdaw
4	350		Jaguar
5	450		Jangle
6	600		Jasmine
8	800		Jasper
10	1500		Jaundice

*Corresponding to diameter of suction opening of pump.



KNOWLES IMPROVED DUPLEX CRANK AND FLY-WHEEL AIR COMPRESSOR.

Size [illegible]

KNOWLES IMPROVED
DUPLEX AIR COMPRESSORS.

HORIZONTAL CRANK AND FLY-WHEEL PATTERN.

THE cut on the opposite page illustrates one of the Knowles Duplex Crank and Fly Wheel Air Compressors. For large plants these duplex compressors are specially suited, since in obtaining a given quantity of air two air cylinders are employed, also two steam cylinders, thus making a machine less cumbersome in its parts than a single compressor of equivalent capacity. At a slight extra cost, this style of compressor can be piped so that either side may be run independently, thus guarding against a total stoppage of the plant should an accident occur to one side of the machine.

This type of compressor is also made cross-compound, either condensing or non-condensing, the high pressure steam cylinder operating one air cylinder and the low pressure steam cylinder operating the opposite air cylinder. The steam cylinders being arranged with cut-off, it not only makes a simple but an economical form of compressor.

The duplex as well as the single compressors are fitted, when specially ordered, with adjustable governors, so that they may be operated at the proper speed with the varying steam pressures so commonly found in factories, etc. Prices on these governors will be quoted on application. The machine throughout is rigid. The fly-wheel end Corliss type of frame, strongly bolted to the steam cylinders, while the air cylinders are tied to the steam cylinders by cast iron distance pieces. The air cylinders are "water-jacketed," each provided with a sight feed lubricator, the valves of improved pattern, the steam cylinders fitted with sight feed lubricators, and all bearings provided with sight feed oil cups. The workmanship and material throughout are of the best, and the efficiency and satisfactory operation of this type of compressor fully guaranteed. We also make cross-compound compressors, condensing and non-condensing. Send for special catalogue of air compressing machinery.

SIZES AND CAPACITIES — STYLE D.

Diameter Steam Cylinder.	Diameter Air Cylinder	Length of Stroke.	Number of Revolutions per Minute.	Cubic Feet Free Air per Minute.	No. of 3-in. Drills or Coal Cutters Compressor will run.	Sizes of Pipes.			Weight of Compressor Complete, Duplex.	Telegraphic Code Word.
						Main Steam.	Exhaust.	Air Discharge.		
8	8	12	160	224	2	2	2	3½	8100	Faubourg
8	10	12	160	350	4	2	2	4	8200	Fauces
10	10	12	160	350	4	2½	3	4	8400	Faulter
10	12	12	160	500	6	2½	3	4½	8500	Faultful
14	14	12	160	684	8	4½	4	5	17000	Faulted
10	10	18	120	393	4	2½	3	4	16000	Faultily
12	12	18	120	564	6	3½	3½	5	17500	Faultless
12	14	18	120	770	10	3½	3½	5	18000	Faulty
12	16	18	120	1004	14	3½	3½	6	21000	Faun
14	14	18	120	770	10	4½	4	6	20000	Fauna
14	16	18	120	1004	14	4½	4	6	22000	Fautor
14	18	18	120	1268	18	4½	4	7	24000	Fautress
16	16	18	120	1004	14	5	6	6	30000	Favored
16	18	18	120	1268	18	5	6	7	35000	Favoring
18	16	18	120	1004	14	5	6	6	36000	Favorite

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

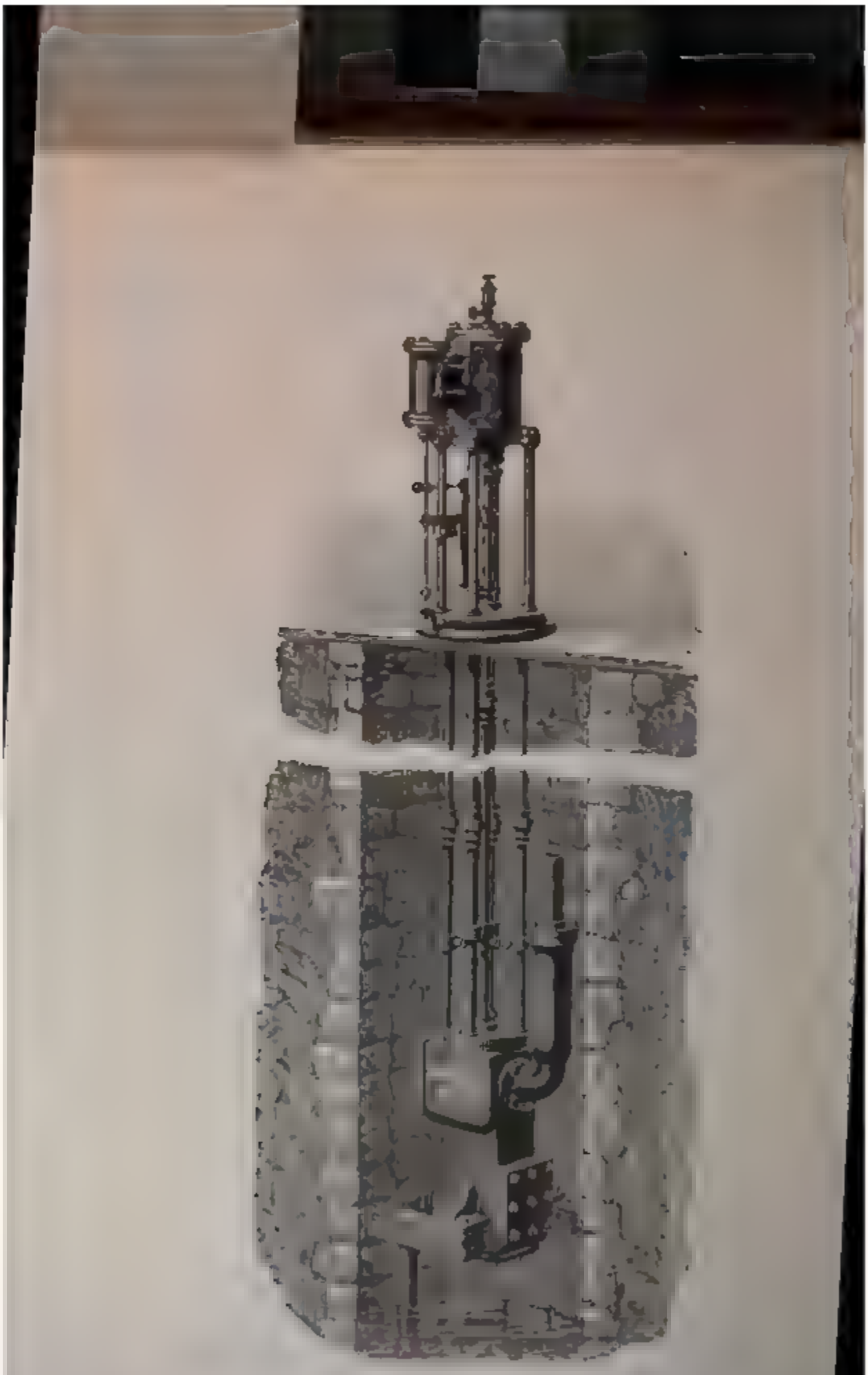
We have built several complete sets of our improved Air Compressing Engines for the largest and most modern designed pneumatic despatch system in the world, aggregating 1600 horse power.

Parties ordering Air Compressors will please state fully the particulars of duty to be performed. If for working rock drills, state size and make of drills. If for running coal cutting machines, pumps, or other like machinery, state size of cylinders, speed, and required air pressure.

POWER AIR COMPRESSORS also made — Duplex or Single pattern. Send for particulars.

SINGLE AIR COMPRESSORS, crank and fly-wheel pattern, see pages 50 and 51.

BREWERS' DUPLEX AIR PUMPS, see pages 42 and 43.



KNOWLES PATENT VERTICAL DEEP WELL PUMP

KNOWLES PATENT

DEEP WELL PUMPS.

Vertical Double-Acting Piston Pattern.

FOR deep wells and other contracted places requiring the steam cylinders and pump cylinders to be placed at considerable distance apart, these improved pumps are especially adapted. They are arranged with double-acting pump cylinders, so that a steady, continuous stream of water is delivered. The steam cylinders being properly proportioned to the water cylinders, they will elevate water to *any* height or distance desired.

These pumps have all the improvements found in our regular horizontal pumps, with the advantage that they take but little room; there is no inconvenience in having to go down in the wells to start or look after steam cylinders, and there is no condensed steam or oil to drop into the water.

The steam cylinder is arranged for bolting to woodwork at the mouth of the well or shaft. The water cylinder can be located at any depth desired, the tie-rods and pump-rod being made of proper length to suit the conditions of each individual case.

The lining, piston rod, stuffing box, valve seats, valve bolts, etc., of the water cylinder are made of the best composition. The water piston is also made of composition and arranged with adjustable packing.

SIZES, CAPACITIES AND PRICES:

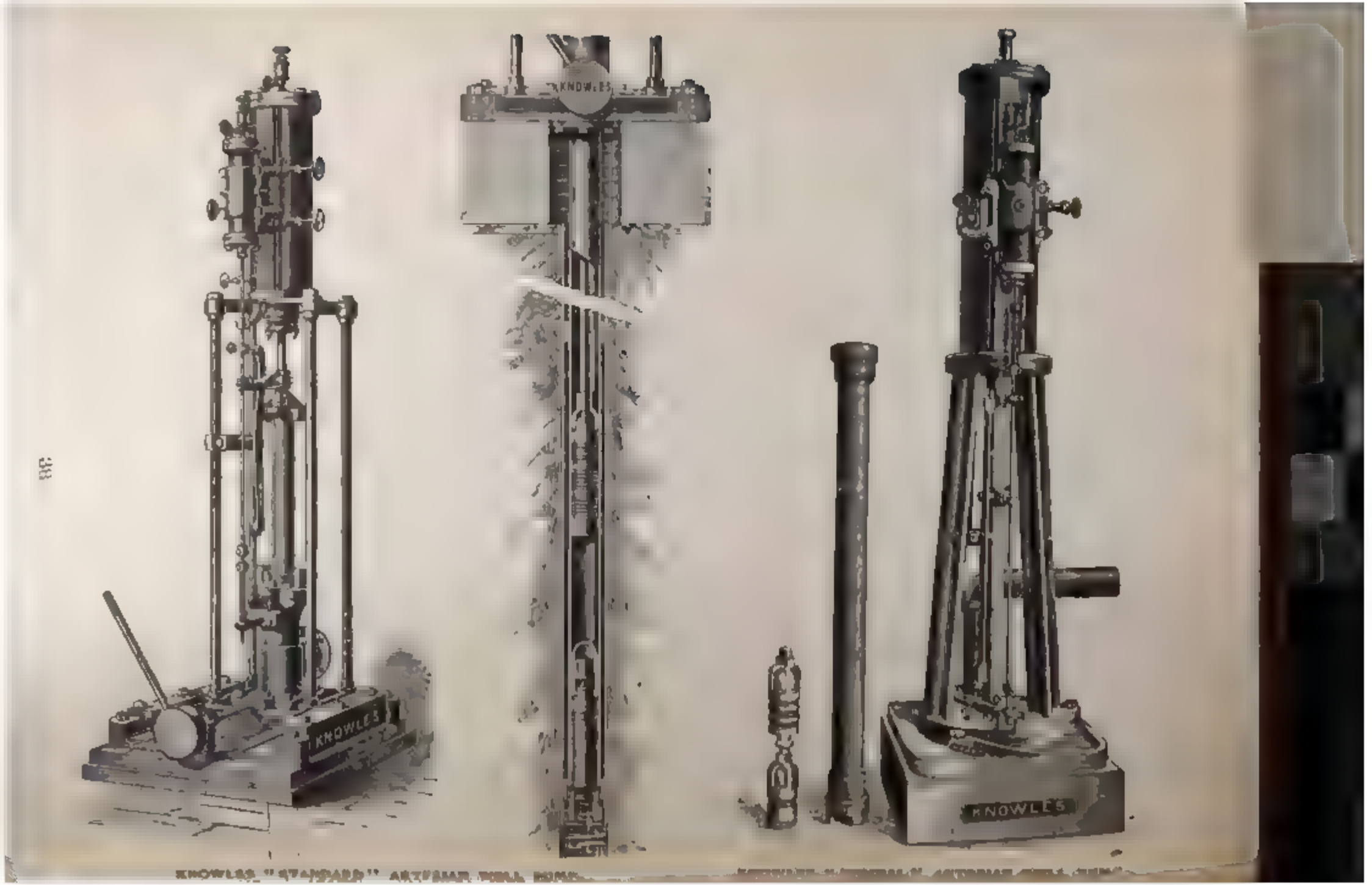
Steam Cylinder. Inches.	Water Cylinder. Inches.	Stroke. Inches	Gallons per Stroke.	• Capacity per Minute at Ordinary Speed.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipe. Inches.	Delivery Pipe. Inches.	Price.
6	4½	7	.48	60 Gallons.	¾	1	2	1½	
6	5	7	.60	70 "	¾	1	3	2½	
6	5½	7	.72	80 "	¾	1	3	2½	
8	5	12	1.02	80 "	1	1¼	3½	3	
8	6	12	1.47	118 "	1	1¼	3½	3	
10	6	12	1.47	118 "	1¼	1½	3½	3	
10	7	12	2.00	160 "	1¼	1½	4	3½	
10	7	18	3.00	160 "	1¼	1½	5	4	
12	7	18	3.00	160 "	2	2½	5	4	
12	8	18	3.92	209 "	2	2½	5	4	
12	9	18	4.96	275 "	2	2½	6	4	
12	10	18	6.12	327 "	2	2½	8	6	
14	8	18	3.92	209 "	2	2½	5	4	
14	9	18	4.96	275 "	2	2½	6	4	
14	10	18	6.12	327 "	2	2½	8	6	
16	10	24	8.16	327 "	2½	3	8	6	
16	12	24	11.75	460 "	2½	3	8	6	
18	14	24	16.00	640 "	3½	4	10	8	

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

• This column gives the capacities at the moderate speed of about 80 feet piston travel per minute. When necessary, this rate of speed can be increased.

Connections to suit any depth of well or shaft, furnished at extra cost.

"ARTESIAN" WELL PUMPS, for bored or driven wells, see next two pages.



KNOWLES "STANDARD" ARTESIAN WELL PUMP.

KNOWLES PATENT

"ARTESIAN" WELL PUMPS.

Vertical Bucket-Plunger Pattern.

THIS improved form of the Knowles Vertical Steam Pump is especially designed for *non*-flowing "Artesian" or bored wells, and for driven pipe wells where the water fails to rise within drafting distance (say 25 feet) of the surface. These pumps are much simpler, less expensive, and not so liable to get out of order as the more complicated and cumbersome "working-beam" or rotative pumps. They will pump from the deepest wells (2000 feet if desired) and deliver a steady stream of water (or oil) to any point.

On the opposite page are given two views, *i.e.*, the steam end, as it appears in position at the mouth of well, and the "working barrel," or pump end, located at the bottom. This latter is a casting of the hardest composition (not soft brass tubing), and is carefully bored out and fitted with pump bucket and foot valve. It is screwed on the lower end of the well piping through which the pump rod works. The pump rod connection between the pump bucket and the upper plunger is made of wood or extra heavy iron pipe. The action of the pump is fully controlled by a perfected arrangement of steam valves, making the up and down strokes equally uniform and regular. The pump bucket discharges water on the up stroke and the upper plunger discharges on the down stroke, consequently the flow of water is steady and continuous. The pump bucket and foot valve are of special construction, and can be readily drawn up through the well piping for examination or repairs.

SIZES AND PRICES:

Steam Cylinder. Inches.	Bucket. Inches.	Plunger. Inches.	Stroke. Inches.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Price.	Capacity at 100 Feet Piston Travel.
4	2¾ to 3¼	1⅞ to 2⅜	7	½	¾		30 to 42 galls. per min.
6	2¾ to 4¼	1⅞ to 3	12	¾	1		30 to 72 " "
8	3¼ to 5¾	2⅜ to 4	24	1	1¼		42 to 112 " "
10	3¼ to 8½	2⅜ to 6	24	1¼	2		42 to 288 " "
12	3¼ to 8½	2⅜ to 6	24	1½	2½		42 to 288 " "
14	3¼ to 8½	2⅝ to 6	24	2	3		56 to 288 " "
16	3¼ to 8½	2⅝ to 6	24	2	3		56 to 288 " "
ALSO PATTERNS FOR LARGER SIZES AND OTHER COMBINATIONS.							

The steam end is arranged to slide to one side upon the bed plate, which feature is very convenient when it is necessary to pull out the pump rods or take up the well piping.

MEMORANDUM.

5 inch Well will take 3 inch Pipe and 2¼ inch Bucket, or 3½ inch Flush joint Pipe, and 3¼ inch Bucket.

5½	"	"	"	3½	"	"	"	3¼	"	"	4	"	"	"	"	"	"	3¾	"	"
6	"	"	"	4	"	"	"	3¾	"	"	4½	"	"	"	"	"	"	4¼	"	"
6½	"	"	"	4½	"	"	"	4¼	"	"	5	"	"	"	"	"	"	4¾	"	"
7½	"	"	"	5	"	"	"	4¾	"	"	6	"	"	"	"	"	"	5¾	"	"
8	"	"	"	6	"	"	"	5¾	"	"	7	"	"	"	"	"	"	6¾	"	"
9	"	"	"	7	"	"	"	6¾	"	"	—	"	"	"	"	"	"	—	"	"
10	"	"	"	8	"	"	"	7¾	"	"	—	"	"	"	"	"	"	—	"	"
12	"	"	"	9	"	"	"	8½	"	"	10	"	"	"	"	"	"	9½	"	"

Regular Piping is more durable than "Flush Joint" piping; the latter, however, being of less diameter outside admits of the use of larger pump buckets and consequently increased pumping capacity.

"Flush Joint" pipe is regular standard wrought iron pipe, without the usual couplings, it has one end of each length boredand tapped—the other end is turned off and threaded. Where it is possible always use regular standard pipe in preference to "Flush joint" pipe or well casing.

***It is well to bear in mind that the pumping capacity of a non-flowing "Artesian" well depends upon the size of its bore. The diameter of the well limits the size of the piping (at the end of which the pump barrel is screwed) and the diameter of this piping limits the size of the pump bucket. Hence only a certain amount of water can be got out of a well of designated bore.

KNOWLES

KNOWLES

KNOWLES PATENT

"ARTESIAN" WELL PUMPS.

Vertical Bucket-Plunger Pattern.

THIS improved form of the Knowles Vertical Steam Pump is especially designed for *non*-flowing "Artesian" or bored wells, and for driven pipe wells where the water fails to rise within drafting distance (say 25 feet) of the surface. These pumps are much simpler, less expensive, and not so liable to get out of order as the more complicated and cumbersome "working-beam" or rotative pumps. They will pump from the deepest wells (2000 feet if desired) and deliver a steady stream of water (or oil) to any point.

On the opposite page are given two views, *i.e.*, the steam end, as it appears in position at the mouth of well, and the "working barrel," or pump end, located at the bottom. This latter is a casting of the hardest composition (not soft brass tubing), and is carefully bored out and fitted with pump bucket and foot valve. It is screwed on the lower end of the well piping through which the pump rod works. The pump rod connection between the pump bucket and the upper plunger is made of wood or extra heavy iron pipe. The action of the pump is fully controlled by a perfected arrangement of steam valves, making the up and down strokes equally uniform and regular. The pump bucket discharges water on the up stroke and the upper plunger discharges on the down stroke, consequently the flow of water is steady and continuous. The pump bucket and foot valve are of special construction, and can be readily drawn up through the well piping for examination or repairs.

SIZES AND PRICES:

Steam Cylinder. Inches.	Bucket. Inches.	Plunger. Inches.	Stroke. Inches.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Price.	Capacity at 100 Feet Piston Travel.
4	2¾ to 3⅛	1⅞ to 2⅜	7	½	¾		30 to 42 galls. per min.
6	2¾ to 4⅛	1⅞ to 3	12	¾	1		30 to 72 " "
8	3⅛ to 5¼	2⅜ to 4	24	1	1¼		42 to 112 " "
10	3⅛ to 8½	2⅜ to 6	24	1¼	2		42 to 288 " "
12	3¼ to 8½	2⅜ to 6	24	1½	2½		42 to 288 " "
14	3¼ to 8½	2⅝ to 6	24	2	3		56 to 288 " "
16	3¼ to 8½	2⅝ to 6	24	2	3		56 to 288 " "

ALSO PATTERNS FOR LARGER SIZES AND OTHER COMBINATIONS.

The steam end is arranged to slide to one side upon the bed plate, which feature is very convenient when it is necessary to pull out the pump rods or take up the well piping.

MEMORANDUM.

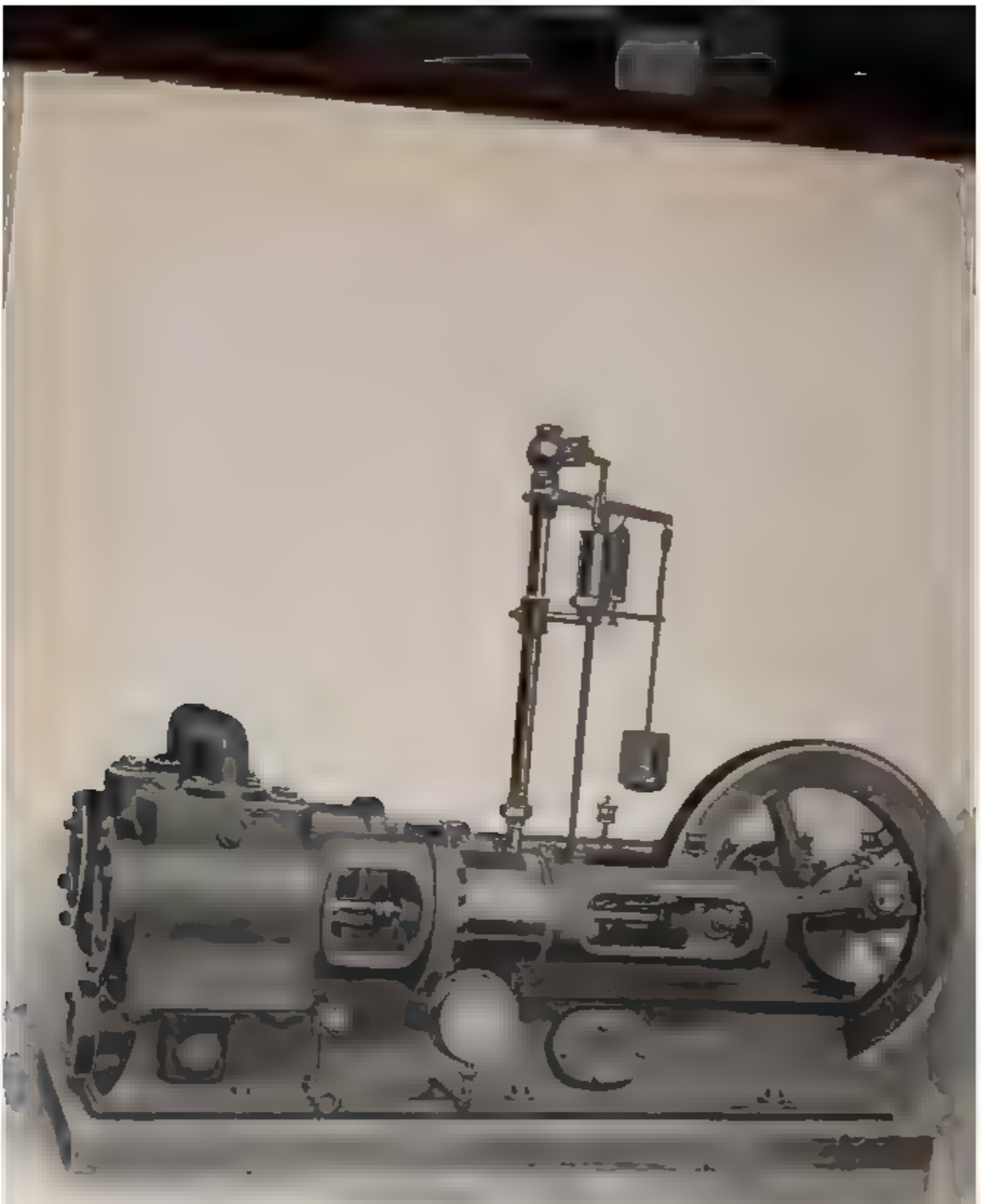
5 inch Well will take 3 inch Pipe and 2⅛ inch Bucket, or 3⅛ inch Flush joint Pipe, and 3¼ inch Bucket.

5⅛	"	"	"	3½	"	"	"	3⅛	"	"	4	"	"	"	"	"	3¾	"	"
6	"	"	"	4	"	"	"	3¾	"	"	4⅛	"	"	"	"	"	4¼	"	"
6½	"	"	"	4½	"	"	"	4¼	"	"	5	"	"	"	"	"	4¾	"	"
7½	"	"	"	5	"	"	"	4¾	"	"	6	"	"	"	"	"	5¼	"	"
8	"	"	"	6	"	"	"	5¾	"	"	7	"	"	"	"	"	6¾	"	"
9	"	"	"	7	"	"	"	6¾	"	"	—	"	"	"	"	"	—	"	"
10	"	"	"	8	"	"	"	7⅞	"	"	—	"	"	"	"	"	—	"	"
12	"	"	"	9	"	"	"	8½	"	"	10	"	"	"	"	"	9½	"	"

Regular Piping is more durable than "Flush Joint" piping; the latter, however, being of less diameter outside admits of the use of larger pump buckets and consequently increased pumping capacity.

"Flush Joint" pipe is regular standard wrought iron pipe, without the usual couplings, it has one end of each length bored and tapped—the other end is turned off and threaded. Where it is possible always use regular standard pipe in preference to "Flush joint" pipe or well casing.

***It is well to bear in mind that the pumping capacity of a non-flowing "Artesian" well depends upon the size of its bore. The diameter of the well limits the size of the piping (at the end of which the pump barrel is screwed) and the diameter of this piping limits the size of the *pump bucket*. Hence only a certain amount of water can be got out of a well of designated *bore*.



KNOWLES PATENT DUPLEX BREWERS' AIR PUMP.

CRANK AND FLY-WHEEL PATTERN

KNOWLES PATENT

BREWERY PUMPS—CONTINUED.

DUPLEX CRANK AND FLY-WHEEL AIR PUMPS.

FOR "RACKING OFF" BEER AND FOR OTHER PURPOSE REQUIRING MODERATE PRESSURE OF AIR.

THIS improved form of Brewers' Air Pump represents our latest designed and best constructed machine for the special purpose intended. These pumps are having a large sale, especially among brewers who are discriminating and who desire to have the *best made* as well as the best working machinery. The pump illustrated on the opposite page fills the want for an efficient and economical air pump for "racking off" and moving beer from place to place.

It is built on the crank and fly-wheel duplex design, with automatic regulating device. The cranks are set at right-angles, so that there is absolutely no "*dead center.*" The operation is therefore perfectly *positive*, enabling the pump to stop and start at any point of stroke, and to work at any speed desired.

The speed of the pump is regulated automatically by the *pressure* of air in the receiver; decreasing the motion as the pressure increases; stopping or slowing down the pump when the required amount of pressure is attained; re-starting it and accelerating the motion in proportion to the withdrawal of the air from the receiver.

The governor valve on the steam pipe is connected with and moved by the *regulator*, which latter is operated by the air pressure. "Racking off" can be carried on at several points at the same time without varying the air pressure perceptibly. The pump does not require any attention from the engineer, as it regulates its own speed, starting and stopping automatically as the air is used or shut off.

SIZES, CAPACITIES AND PRICES:

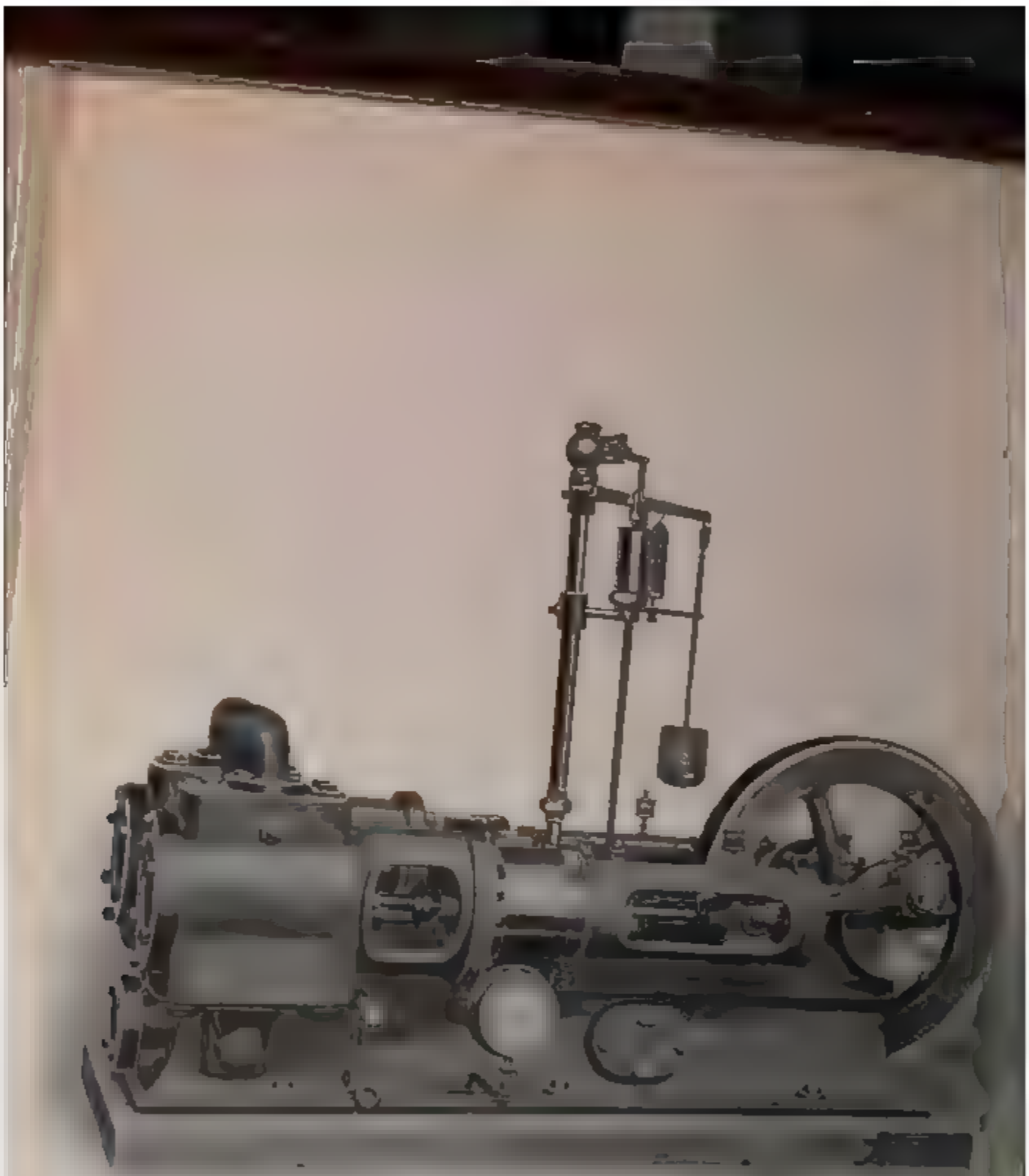
Steam Cylinders. Inches.	Air Cylinders. Inches.	Stroke. Inches.	Cubic Feet Air per Revolution.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipe. Inches.	Delivery Pipe. Inches.	Price.
4	5	5	.30	¾	1	2½	1½	
6	7	6	.55	1	1½	3	2	
6	8	6	.75	1	1½	3	2	
8	10	8	1.45	1¼	2¼			
8	12	8	2.00	1½	2½			

ALSO PATTERNS FOR LARGER SIZES AND OTHER COMBINATIONS OF CYLINDERS.

The small amount of water used in the air cylinders to cool the air, seal the valves, and fill the cylinder heads, will accumulate in the bottom of the air receiver. The glass water-gauge is intended to show the height of this water and designate when it is necessary to draw it off through the drain cock, shown.

Every pump is carefully tested under pressure at the factory before shipment, and is therefore

FULLY WARRANTED.



KNOWLES PATENT DUPLEX BREWERS' AIR PUMP.

CRANK AND FLY WHEEL PATTERN

KNOWLES PATENT

BREWERY PUMPS—CONTINUED.

DUPLEX CRANK AND FLY-WHEEL AIR PUMPS.

FOR "RACKING OFF" BEER AND FOR OTHER PURPOSE REQUIRING MODERATE PRESSURE OF AIR.

THIS improved form of Brewers' Air Pump represents our latest designed and best constructed machine for the special purpose intended. These pumps are having a large sale, especially among brewers who are discriminating and who desire to have the *best made* as well as the best working machinery. The pump illustrated on the opposite page fills the want for an efficient and economical air pump for "racking off" and moving beer from place to place.

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The governor valve on the steam pipe is connected with and moved by the *regulator*, which latter is operated by the air pressure. "Racking off" can be carried on at several points at the same time without varying the pressure perceptibly. The pump does not require any attention from the engineer, as it regulates its own speed, starting and stopping automatically as the air is used or shut off.

SIZES, CAPACITIES AND PRICES:

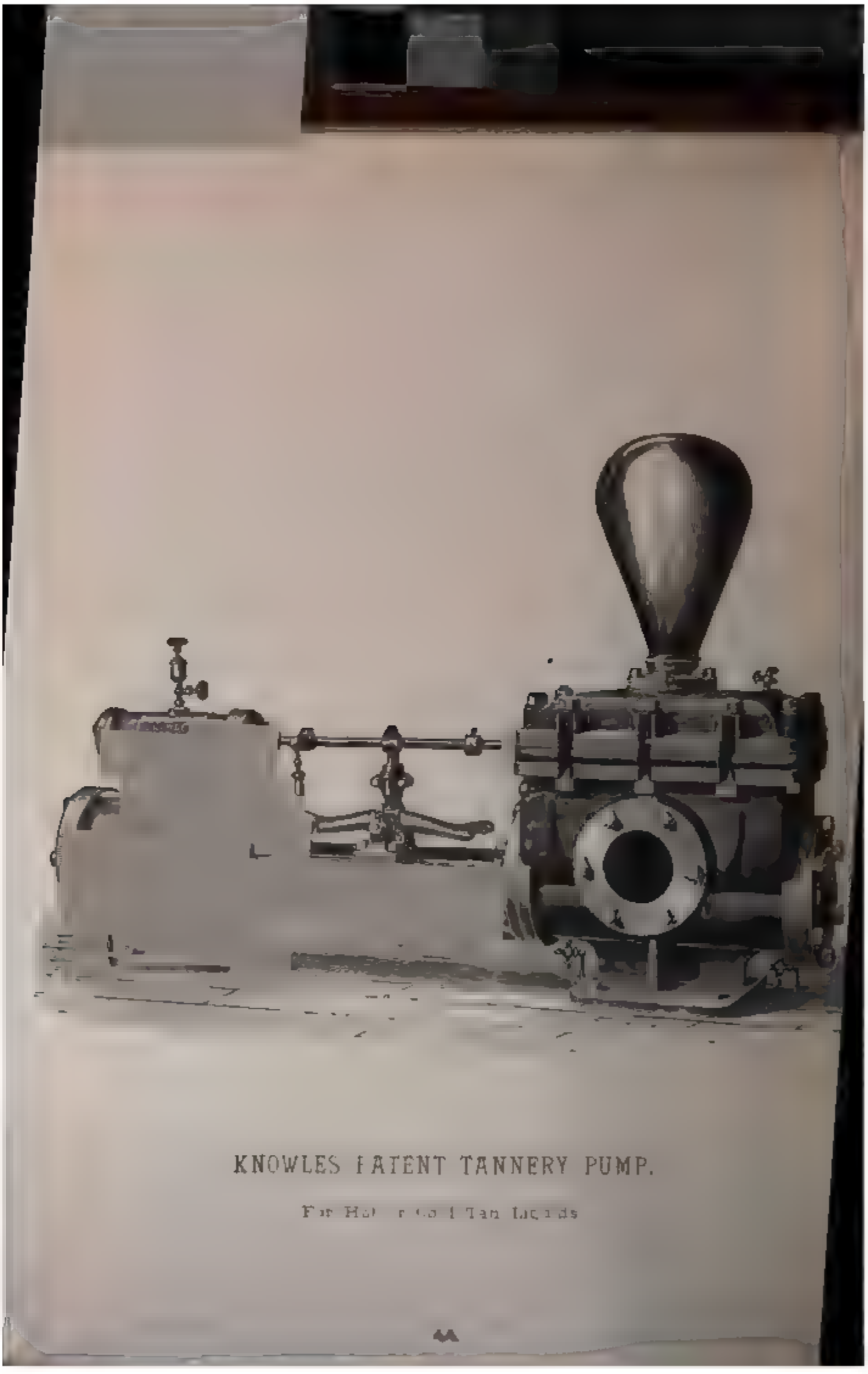
Steam Cylinders. Inches.	Air Cylinders. Inches.	Stroke. Inches.	Cubic Feet Air per Revolution.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipe. Inches.	Delivery Pipe. Inches.	Price.
4	5	5	.30	¾	1	2½	1½	
6	7	6	.55	1	1½	3	2	
6	8	6	.75	1	1½	3	2	
8	10	8	1.45	1¼	2¼			
8	12	8	2.05	1½	2½			

ALSO PATTERNS FOR LARGER SIZES AND OTHER COMBINATIONS OF CYLINDERS.

The small amount of water used in the air cylinders to cool the air, seal the valves, and fill the cylinder heads, will accumulate in the bottom of the air receiver. The glass water-gauge is intended to show the height of this water and designate when it is necessary to draw it off through the drain cock, shown.

Every pump is carefully tested under pressure at the factory before shipment, and is therefore

FULLY WARRANTED.



KNOWLES PATENT TANNERY PUMP.

For Hot or Cold Tan Liquids

KNOWLES PATENT

OIL-LINE PUMPS.

(FOR "LOCAL" LINES.)

Piston Pattern, with Patent Removable Cylinders.

THE rough usage that steam pumps of necessity must receive on the "local" oil lines, requires them to be of the strongest and most durable construction and at the same time easily handled and transported. We have special patterns for these pumps combining all the latest improvements—including our patent universal *removable* cylinder. All the working parts are of the most durable character and made of materials especially selected. The pump valves are of improved form; each valve is held in position by an independent screw cap and with its seat can be quickly taken out and examined; a duplicate valve or seat can therefore be substituted with little trouble or loss of time, when necessary.

The pump cylinder and its valve chests are cast in one piece and consequently have no joints to leak or bolts to get loose; this solid design also gives great strength without excessive weight.

All parts are INTERCHANGEABLE, so that in case of accidental breakage or unusual wear, they can be readily replaced by duplicate pieces.

SIZES, CAPACITIES AND PRICES:

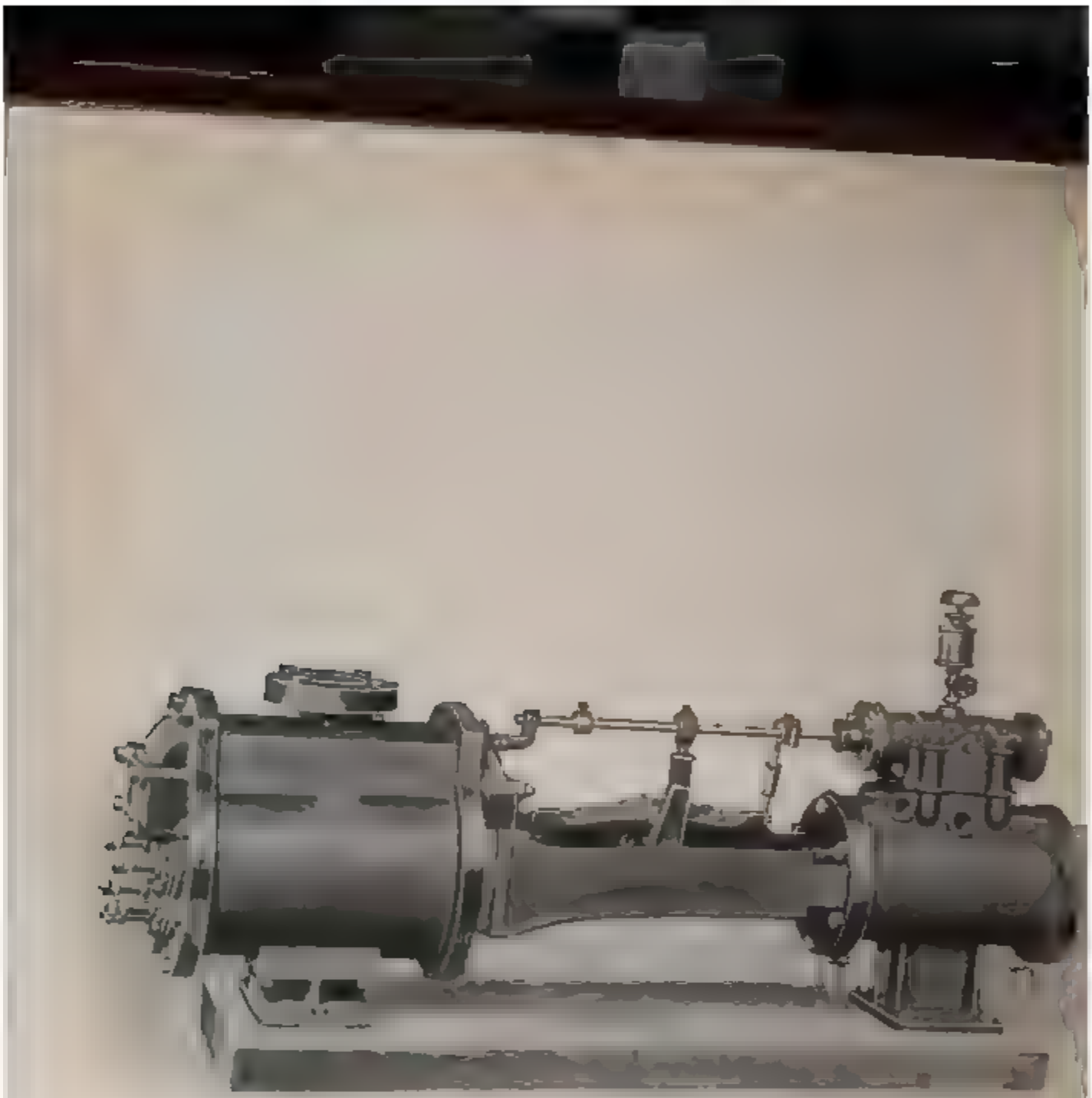
Size.	Steam Cylinder. Inches.	Oil Cylinder. Inches.	Stroke. Inches.	Gallons per Stroke.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction. Inches.	Delivery Pipe. Inches.	Price.
A	4	3	5	.16	½	¾	2 in. Pipe.	2	
B	6	3	7	.22	¾	1	2 " "	2	
C	7½	3	10	.31	1	1¼	2 " "	2	
D	8	3½	10	.44	1	1¼	3¼ in. Casing.	2	
F	10	4	12	.65	1¼	1½	3¼ " "	2	
H	12	4½	12	.82	2	2½	3¼ " "	2	
I	14	5	12	1.02	2	2½	3¼ " "	2	
	14	5	16	1.53	2	2½			
	16	5	16	1.53	2½	3			
	16	5	24	2.04	2½	3			
	18	5	16	1.53	2½	3			
	18	5	24	2.04	3½	4			

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

The prices given above are for the Improved Oil-Line Pumps arranged (without extra charge) with Knowles

PATENT REMOVABLE CYLINDERS,

the utility of which will be readily appreciated, especially where much sand or grit prevails. It is a substantial casting of gun metal composition or phosphor bronze, arranged so that it can be easily turned and secured in a new position when the lower side becomes cut or worn.



KNOWLES PATENT BLOWING ENGINE.

IMPROVED DIRECT-ACTING PATTERN.

KNOWLES PATENT

BLOWING ENGINES.

Direct-Acting.

THESE improved blowing engines are largely used for agitating oils, acids and chemical preparations, also for blast and ventilating purposes. Being on the direct-acting system, they are very compact and simple. No costly foundations are necessary and the expense for attendance and maintenance is comparatively nothing. They are universally used in the oil refineries of this country and Russia and are largely employed in smelting works, blast furnaces, etc.

Our improved compensating valve motion is of special value on these blowing engines, as the length of stroke can be readily and finely adjusted, so that the pistons can be made to travel close up to the heads of the air cylinders, thus combining greatest economy in use of steam with most efficient work. The air valves are not liable to derangement and are of very durable form. The air pistons are made light and strong, and are provided with adjustable packing of improved design.

SIZES, CAPACITIES AND PRICES:

Steam Cylinders. Inches.	Air Cylinder Inches.	Stroke. Inches.	Cubic ft of Air per Stroke.	Capacity per Minute at Ordinary Speed.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Delivery Pipe. Inches.	Price.	REMARKS
4	4½	5	.04	200 Strokes, 16 Cu. ft.	½	¾	According to circumstances.		
4½	8	7	.19	200 " 38 "	¾	1			
4½	10	7	.27	200 " 54 "	¾	1			
6	8	12	.34	150 " 51 "	¾	1			
6	15	6	.66	150 " 99 "	¾	1			
6	10	12	.54	150 " 81 "	¾	1			
8	12	12	.78	150 " 117 "	1	1¼			
8	14	12	1.07	150 " 160 "	1	1¼			
10	16	16	2.09	100 " 209 "	1¼	1½			
10	18	16	2.75	100 " 275 "	1½	1½			
10	20	16	2.90	100 " 290 "	1½	1½			
12	20	24	4.36	75 " 327 "	2	2½			
12	24	24	6.30	75 " 473 "	2	2½			
14	24	24	6.30	75 " 473 "	2	2½			
14	30	16	6.54	100 " 654 "	2	2½			
14	30	36	14.72	50 " 736 "	2	2½			
16	30	36	14.72	50 " 736 "	2½	3			
18	30	36	14.72	50 " 736 "	3	3½			
18	36	36	21.20	50 " 1060 "	3	3½			
20	42	48	38.50	40 " 1540 "	3½	4			
24	48	48	50.27	40 " 2010 "	4	4½			

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

Where greater economy of steam is desired, we recommend that the larger sizes of these blowing engines should be arranged to run *condensing*. When a sufficient supply of injection water is obtainable, it is but little trouble or expense to attach our independent air pump and condenser.

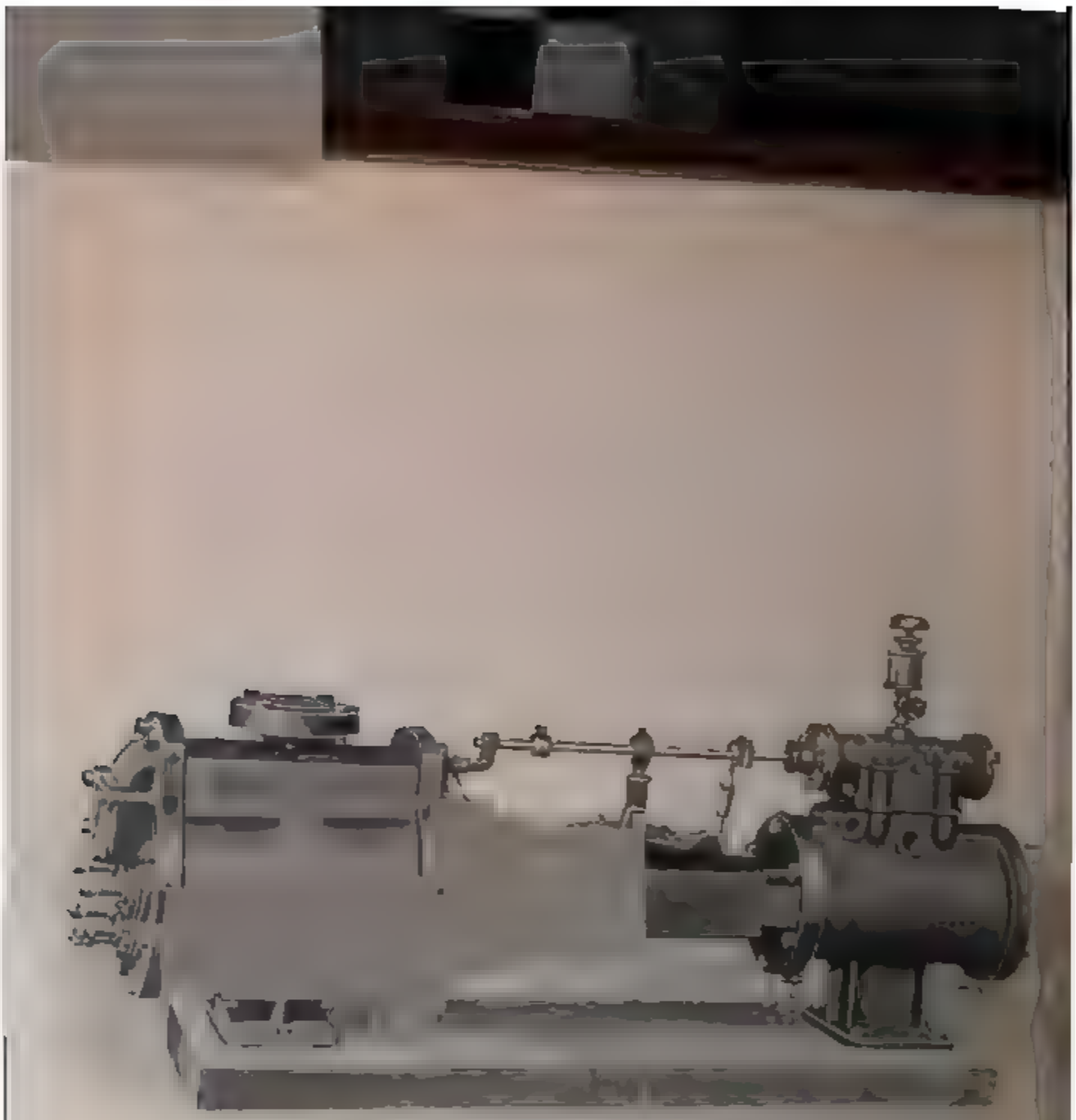
AIR PUMPS (single fly-wheel pattern) for elevating sulphuric acids, etc., are described on next two pages.

AIR COMPRESSORS—duplex crank and fly-wheel pattern—see pages 34 and 35.

OIL REFINERY PUMPS.

For Crude and Refined Oil, Naphtha, Tar, etc.

These pumps are constructed with special reference to the work to be performed, and are made from improved designs and new patterns. For dimensions and prices of pumps, to work on limited elevations, refer to pages 8 and 9—price-list of "TANK OR LIGHT SERVICE PUMPS." For heavier duties, see pages 4 and 5—price-list of "BOILER FEED OR PRESSURE PUMPS."



KNOWLES PATENT BLOWING ENGINE.

IMPROVED DIRECT-ACTING PATTERN.

THE KNOWLES
SINGLE CYLINDER CRANK AND FLY-WHEEL
AIR COMPRESSOR.

For Elevating Acids by Air Pressure, for Operating Pneumatic Machinery, etc.

THESE "Straight-Line" Air Compressors are made, in the smaller sizes, with the air valves located in the air cylinder heads. The larger sizes may be provided with radial valves located around the air cylinder barrel, as shown in the cut on the opposite page. It will be seen at a glance that this type of compressor is very compact and thoroughly self-contained, and, when properly set, its perfect alignment in continuous service can be relied upon.

Steam and air cylinders are both provided with sight feed lubricators, and all the bearings are fitted with sight feed oil cups. The air cylinder is "water jacketed," and so arranged that the cooling water enters at the compression ends of the cylinders, and after the heat due to compression is absorbed, the water is discharged at the centre.

In large plants where the saving in steam consumption is sufficient to warrant the extra cost, these compressors are fitted with Corliss valve gear and may be run condensing or non-condensing.

Where the air or gas is required to be compressed to pressures greater than about one hundred pounds per square inch, we recommend the use of a compressor with *compound air end*, having two or more air cylinders of different sizes. The initial compression takes place in the larger cylinder. After this first compression, the air or gas passes on to the next cylinder, where the pressure is still further increased, and, if there is a third air cylinder, the process is again continued until the required pressure is reached.

SIZES AND CAPACITIES.—VALVES IN HEADS.—STYLES A AND B.

Diameter of Steam Cylinder.	Diameter of Air Cylinder.	Length of Stroke.	Number of Revolutions per Minute.	Cubic Feet of Free Air per Minute.	No. of 3 in. Drills or Coal Cutters Compressor will run.	Size of Steam Pipe.	Size of Exhaust Pipe.	Size of Air Pipe.	Weight of Compressor Complete.	Telegraphic Code Word.
6	5	7	180	29		1	1½	1½	1000	Farrier
6	6	7	180	42		1	1½	1½	1100	Farrow
6	7	7	180	56		1	1½	1½	1700	Farthest
8	7	7	180	56		1¼	2	2	1800	Farthing
8	8	7	180	73		1¼	2	2	1900	Fascicle
8	8	12	160	112	1	1½	2½	2½	2600	Fascinate
8	10	12	160	175	2	1½	2½	3	3900	Fashion
10	10	12	160	175	2	2	3	3	4100	Fastener
10	12	12	160	250	3	2	3	3½	4900	Fastening
10	12	16	140	292	3	2	3	3½	6100	Faster
12	10	12	160	175	2	2¼	3½	3	5000	Fastidious
12	12	12	160	250	3	2½	3½	3½	5200	Fasting
12	12	16	140	292	3	2½	3½	3½	6300	Fatal
12	14	16	140	399	5	2½	3½	4	8100	Fatalist
14	12	16	140	292	3	3½	4	3½	8200	Fatality
14	14	16	140	399	5	3½	4	4	9500	Fatally

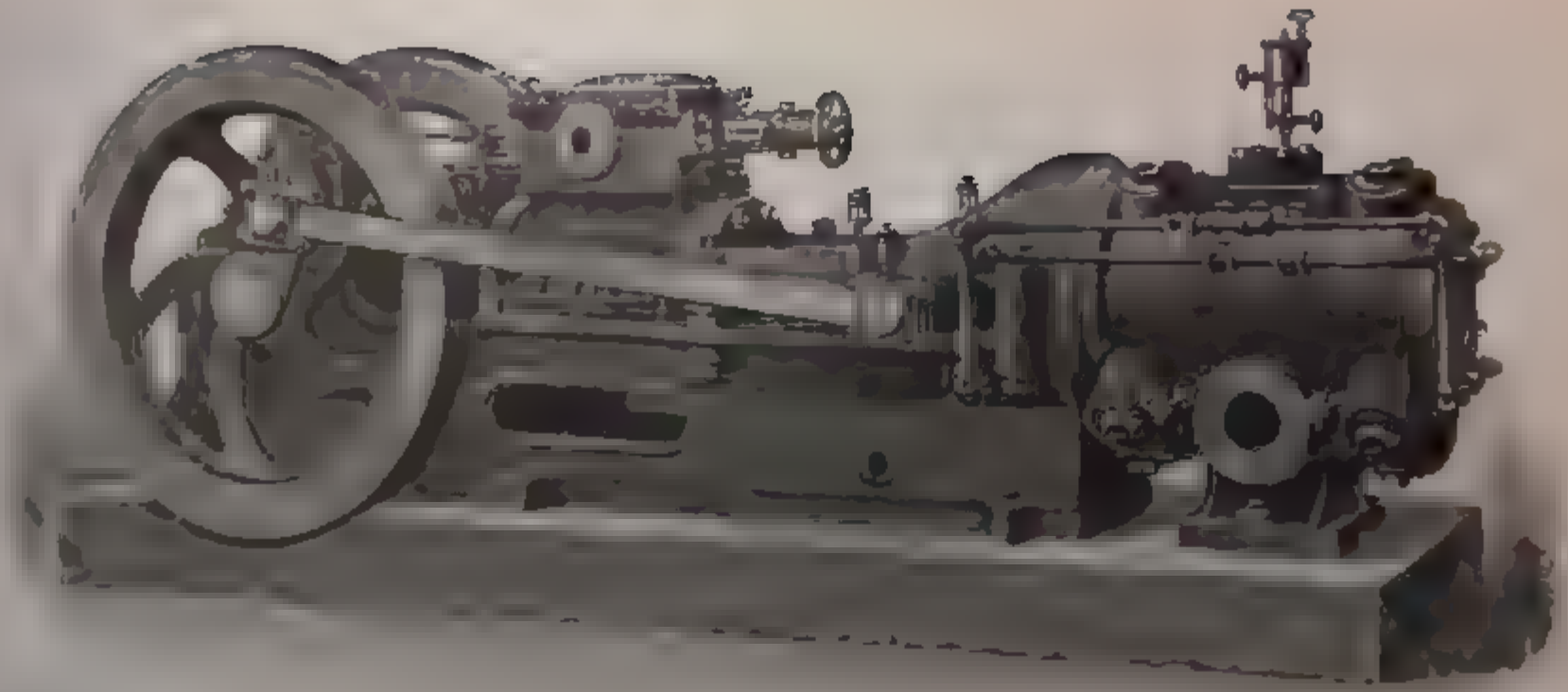
WITH RADIAL VALVES.—STYLE C.

12	12	18	120	282	3	2½	3½	3½	8000	Fated
*12	12	18	120	282	3	2½	3½	3½	9700	Fateful
12	14	18	120	385	5	2½	3½	4	10800	Father
*12	14	18	120	385	5	2½	3½	4	11800	Fatherly
14	14	18	120	385	5	3	4	4	11500	Fathom
*14	14	18	120	385	5	3	4	4	12000	Fatigue
*14	16	18	120	502	7	3	4	4½	12500	Fatling
*16	16	18	120	502	7	3½	4	4½	14000	Fatly
*16	18	18	120	634	9	3½	4	5	16000	Fatness
*18	18	18	120	634	9	4½	5	5	18000	Fatras
*16	18	24	95	670	10	4	5	5	20000	Fatted
*18	18	24	95	670	10	4½	5	5	23000	Fatten
*18	20	24	95	828	12	5	5	6	24000	Fattish
*20	20	24	95	828	12	5	6	6	25000	Fatty
*24	24	30	75	1177	16	6	7	6	34600	Fatuity

* Table gives weight when fitted with Meyer cut-off.

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

The Meyer cut-off attachment, shown in the cut on the opposite page, is only furnished when specially ordered, and is charged extra. Cut shows radial valves. Send for special catalogue of air compressing machinery.



THE KNOWLES IMPROVED STRAIGHT LINE AIR COMPRESSOR.

Size [illegible]

With Meyer [illegible] Radial Valves

THE KNOWLES
SINGLE CYLINDER CRANK AND FLY-WHEEL
AIR COMPRESSOR.

For Elevating Acids by Air Pressure, for Operating Pneumatic Machinery, etc.

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SIZES AND CAPACITIES.—VALVES IN HEADS.—STYLES A AND B

Diameter of Steam Cylinder	Diameter of Air Cylinder	Length of Stroke.	Number of Revolutions per Minute.	Cubic Feet of Free Air per Minute.	No. of 3 in. Drills or Coal Cutters Compressor will run.	Size of Steam Pipe.	Size of Exhaust Pipe.	Size of Air Pipe.	Weight of Compressor Complete.	Telegraphic Code Word.
6	5	7	180	29		1	1½	1½	1000	Farmer
6	6	7	180	42		1	1½	1½	1100	Farrow
6	7	7	180	56		1	1½	1½	1200	Farther
8	7	7	180	56		1¼	2	2	1300	Farming
8	8	7	180	73		1¼	2	2	1400	Fascine
8	8	12	160	112	1	1½	2½	2½	2000	Fascinate
8	10	12	160	175	2	1½	2½	3	2200	Fashion
10	10	12	160	175	2	2	3	3	4100	Fastener
10	12	12	160	250	3	2	3	3½	4200	Fastening
10	12	16	140	292	3	2	3	3½	4300	Faster
12	10	12	160	175	2	2¼	3½	3	5000	Fastidious
12	12	12	160	250	3	2½	3½	3½	5200	Fasting
12	12	16	140	292	3	2½	3½	3½	6300	Fatal
12	14	16	140	399	5	2½	3½	4	7100	Fatalist
14	12	16	140	292	3	3½	4	3½	8200	Fatality
14	14	16	140	399	5	3½	4	4	9500	Fatalize

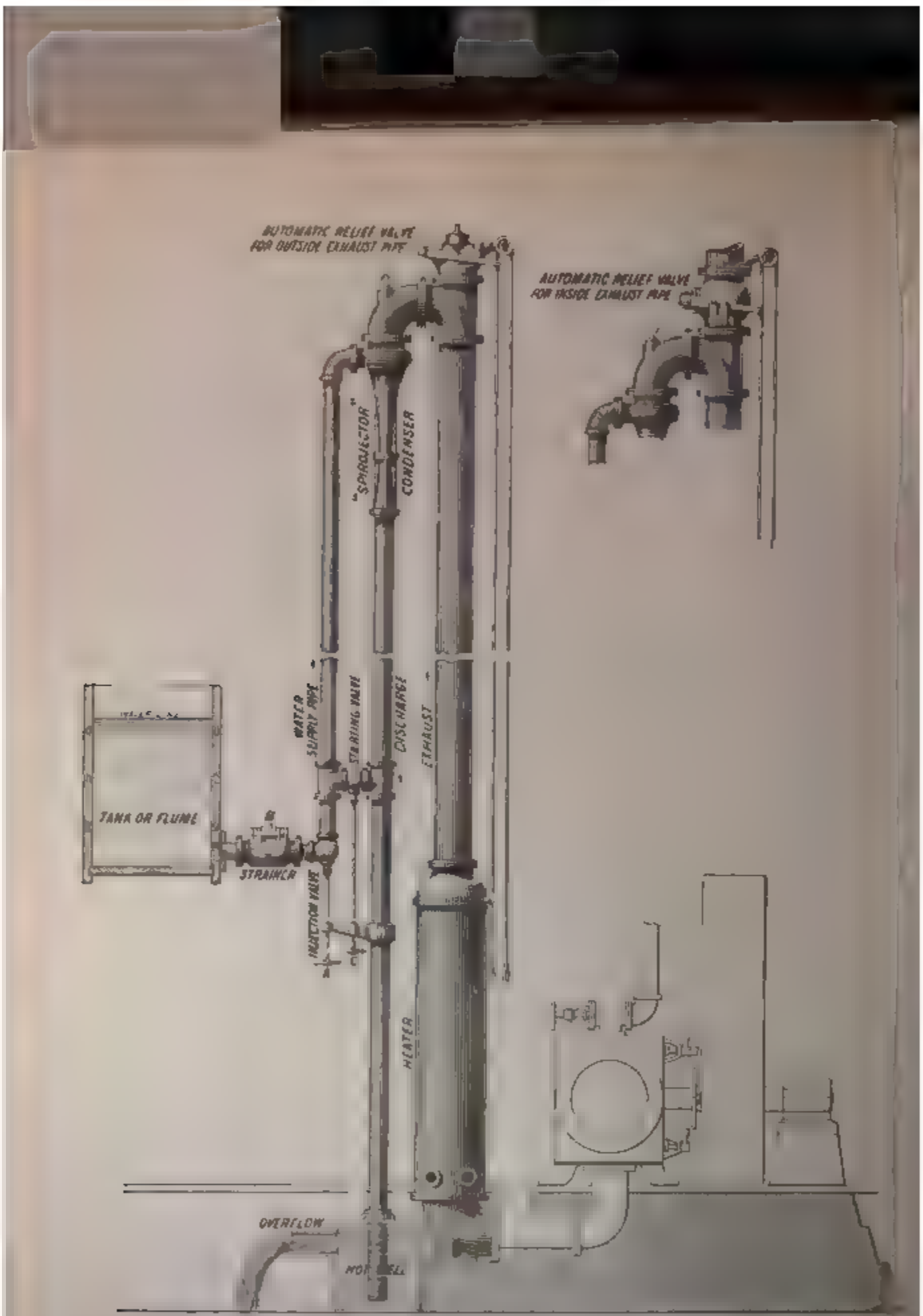
WITH RADIAL VALVES.—STYLE C.

12	12	18	120	282	3	2½	3½	3½	8000	Fated
*12	12	18	120	282	3	2½	3½	3½	9700	Fateful
12	14	18	120	385	5	2½	3½	4	10500	Father
*12	14	18	120	385	5	2½	3½	4	11500	Fatherly
14	14	18	120	385	5	3	4	4	11500	Fathom
*14	14	18	120	385	5	3	4	4	12000	Fatigue
*14	16	18	120	502	7	3	4	4½	12500	Fatling
*16	16	18	120	502	7	3½	4	4½	14000	Fatly
*16	18	18	120	634	9	3½	4	5	16000	Fatness
*16	18	18	120	634	9	4½	5	5	15000	Fatras
*18	18	24	95	670	10	4	5	5	20000	Fatted
*18	18	24	95	670	10	4½	5	5	23000	Fatten
*20	20	24	95	828	12	5	5	6	24000	Fattish
*20	20	24	95	828	12	5	6	6	25000	Fatty
*24	24	30	75	1177	16	6	7	6	34000	Fatuity

* Table gives weight when fitted with Meyer cut-off.

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

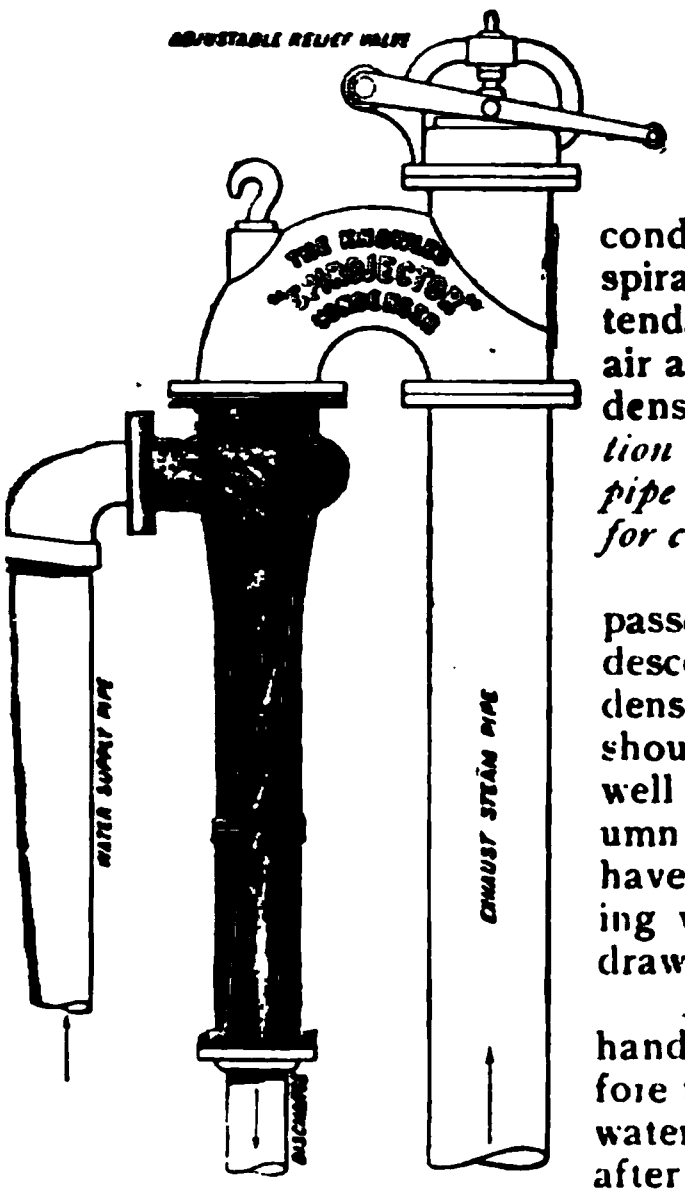
The Meyer cut-off attachment, shown in the cut on the opposite page, is only furnished when specially ordered, and is charged extra. Cut shows radial valves. Send for special catalogue of air compressing machinery.



THE KNOWLES PATENT "SPIROJECTOR" CONDENSER.

SYPHONING ITS SUPPLY OF WATER FROM FLUME OR PENSTOCK

KNOWLES PATENT SPIROJECTOR CONDENSER.

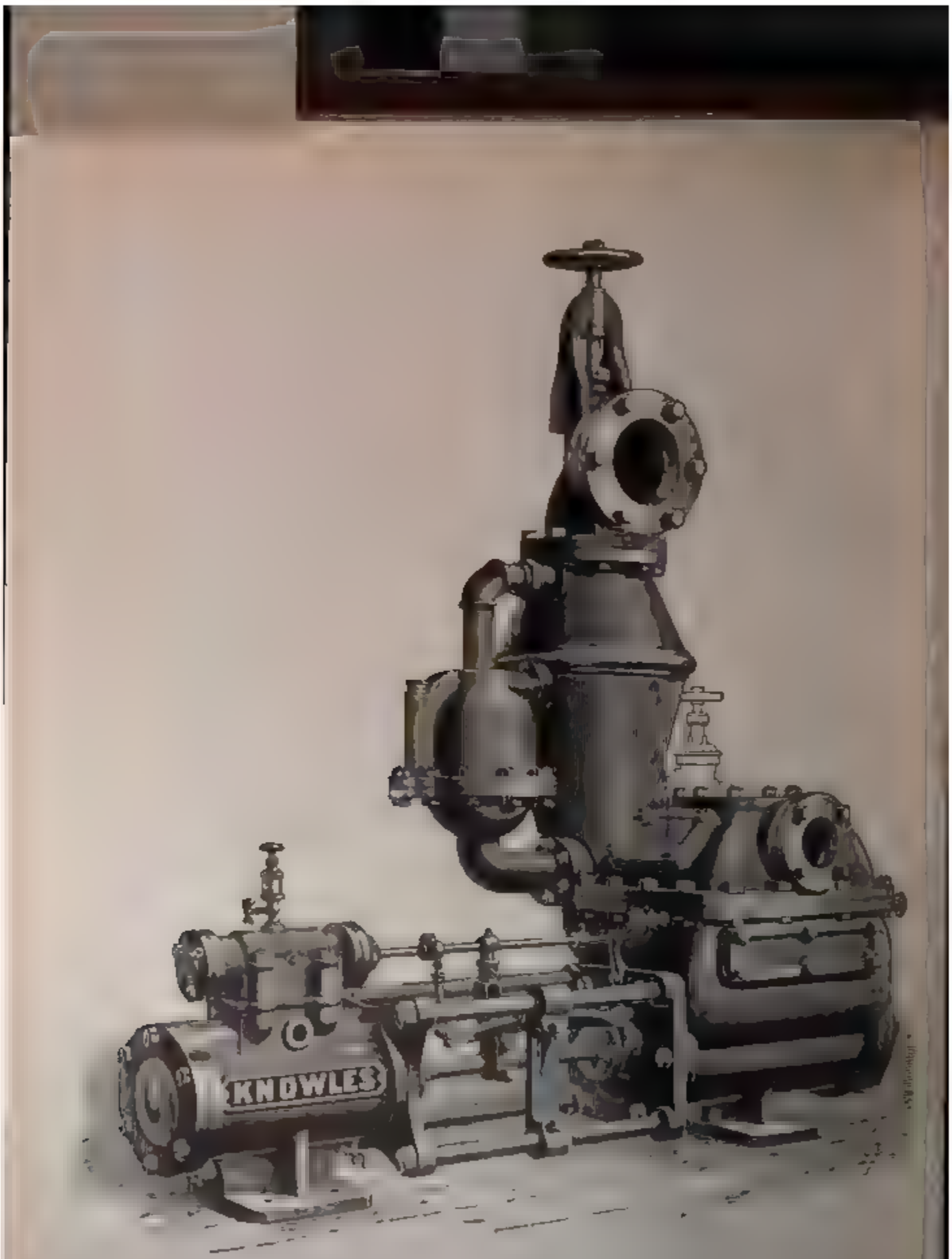


THE accompanying engraving illustrates our patent "Spirojector" Condenser, an improved form of the syphon system of jet condenser, and the best yet introduced. Particular attention is called to the arrangement of the cone in the upper part of the condenser, whereby the injection water is made to take a spiral or rotary direction in its downward flow. This action tends to produce a more perfect effect in drawing down the air and vapors through the narrow or middle part of the condenser. *That is to say, the whirling action given to the injection water as it passes through the condenser to the discharge-pipe produces the best results and with the use of less water for condensing the steam.*

The exhaust steam entering at the top of the condenser passes through the center of the cone and meets the rapidly descending spiral current of water and is immediately condensed. The "barometrical column" or discharge-pipe should be sufficiently long between the condenser and hot well (say a height of at least thirty feet) to support the column of water by the pressure of the atmosphere, and yet have the condenser itself kept clear for the rapidly descending water to carry the air down into the hot well after it is drawn through the condenser.

As shown, the injection water enters at the upper left-hand side of the condenser, circulating around the cone before taking the spiral action above described. The injection water can be syphoned from a tank, flume, or penstock after the vacuum is formed in the condenser, if the supply of water is not less than ten feet above the overflow-pipe of the hot well. If the supply of water is less than ten feet, then it is necessary to use a pump.

The engraving on opposite page represents our improved "Spirojector" Condenser as attached to a steam engine and drawing the condensing water by "syphon" action from a tank, flume, or other water supply. This plan of supplying the condenser is available where the head of water is not less than ten feet above the overflow-pipe of the hot well. A supply-pipe of ample size should be used to convey the injection water from flume, penstock, or tank up to the condenser. On this pipe, at the most convenient point, must be provided a suitable injection-valve (as shown at "A") for regulating the quantity of water. A proper screen or strainer, with a large number of small holes, should be placed over the end of this pipe in the flume or tank, or, if preferred, one of our Special Box Strainers of ample size (as shown at "B") should be used on the pipe. The advantage of this form of strainer is the convenience with which it can be opened and cleaned. The cross pipe and valve shown at "C" is for the purpose of starting the vacuum in the discharge-pipe of condenser; when sufficient vacuum is formed to cause the water to flow up the supply-pipe and through the condenser, then this starting valve ("C") should be closed, as the amount of injection water is regulated by the injection-valve "A." Once the condenser is properly started there is no trouble about holding continuously a steady and high vacuum; even if the head of water should fall to a point as low as ten feet above overflow of hot well (after the vacuum is once formed) the condenser will continue to syphon its water in sufficient quantity. Prices and further particulars on application. Send for special catalogue of condensing apparatus.



KNOWLES PATENT AIR PUMP AND JET CONDENSER.

REGULAR HORIZONTAL PATTERN.

The engraving above represents a pump having 8 inch steam cylinder, 12 inch air cylinder 12 inch stroke

KNOWLES PATENT
AIR PUMP AND JET CONDENSER.

REGULAR HORIZONTAL PATTERN.

THE Knowles Independent Condensing Apparatus will save from twenty to thirty per cent. in steam when applied to non-condensing steam engines, or will give an increase of power of corresponding amount. It requires no expensive foundation, and can readily be attached, and placed in any position most convenient — under the engine room floor if desired.

Each pump is provided with composition-lined air cylinder, composition piston rod, specially vulcanized rubber valves, composition valve-seats and valve-bolts; valve-springs of phosphor-bronze. The piston of the air cylinder is made of composition, with adjustable fibrous packing.

TABLE OF SIZES, ETC.

AIR PUMP						CONDENSER		*Capacity, i.e., Weight of Steam used per Hour in Main Engine	Price	Telegraphic Code Word
Steam Cylinder	Air Cylinder	Stroke	Steam Pipe	Exhaust Pipe	Discharge Pipe	Injection Inlet	Exhaust Inlet			
Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Pounds		
5½	8	7	¾	1	3	2	TO SUIT EXHAUST PIPE OF ENGINE.	1560		Habeas
6	9	10	¾	1	4	3		2240		Habeck
6	10	12	¾	1	5	4		3340		Habendum
8	12	12	1	1¼	5	4		4800		Habile
8	14	12	1	1¼	6	5		6400		Hability
8	14	16	1	1¼	6	5		6540		Habitat
10	14	16	1¼	1½	6	5		6540		Habitual
10	16	16	1¼	1½	8	6		8540		Habitude
12	18	18	2	2½	8	6		10800		Habnab
12	18	24	2	2½	8	7		11000		Hackery
12	20	24	2	2½	10	7		13340		Hackle
14	20	24	2½	3	10	7		13340		Hackney
14	22	24	2½	3	10	8		16140		Hackster
14	24	24	2½	3	12	8		19200		Hadbote
16	26	24	2½	3	12	10		22540		Hadder
16	28	24	2½	3	12	10		26140		Hading

ALSO PATTERNS FOR SMALLER AND LARGER SIZES, OR OTHER COMBINATIONS.

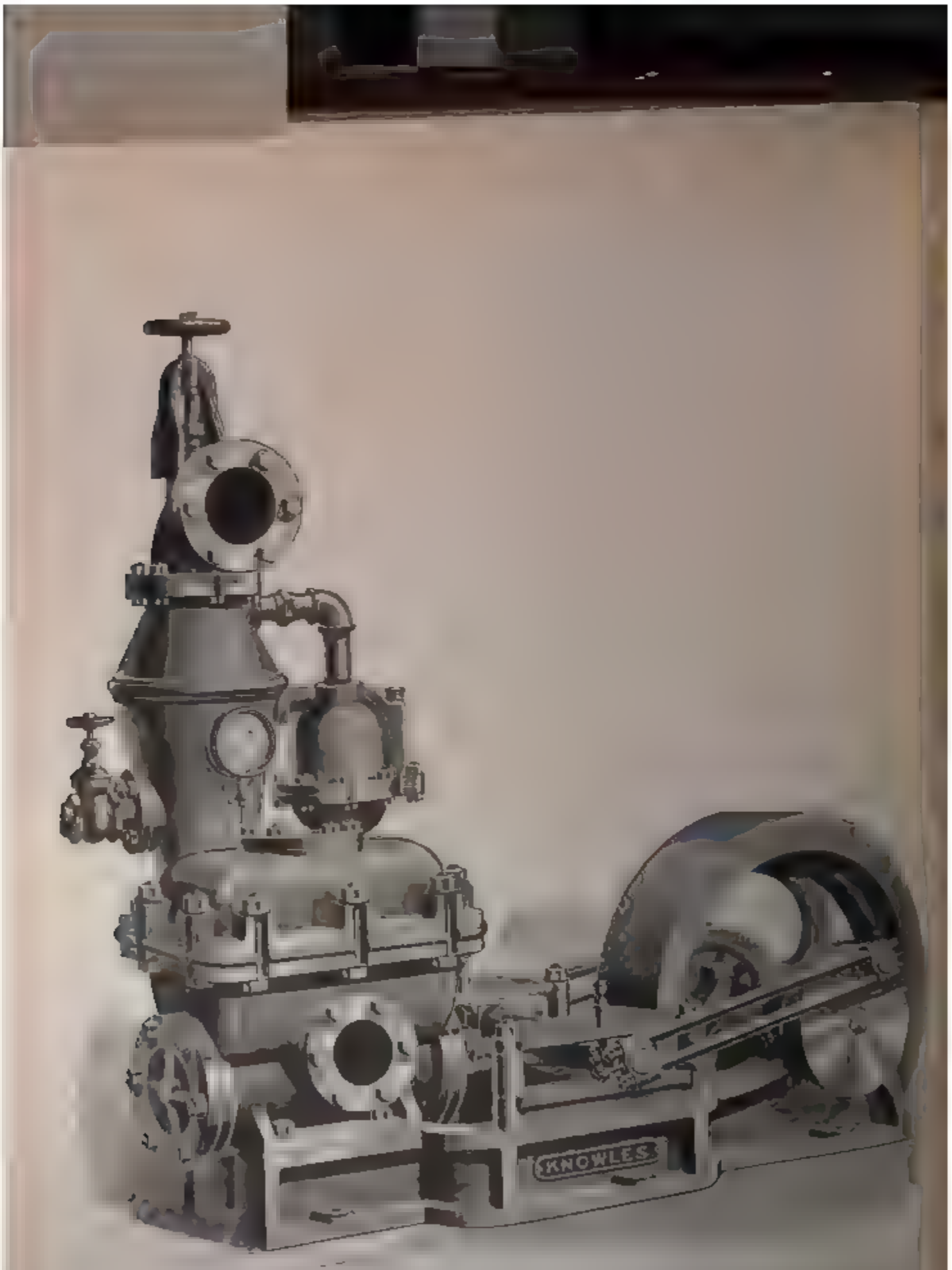
*The above capacities are figured on a basis of condensing water not exceeding a temperature of 70 deg. F.; in case of colder or warmer water, smaller or larger sizes should be selected.

With each air pump and jet condenser we furnish a lubricator, drip-cocks, and full set of spanners and socket wrenches.

The engraving shows a gate valve on the injection pipe. This valve is not furnished with the condenser (unless specially ordered), but should always be placed on the injection pipe at the most convenient point near the condenser.

Send for the Knowles Special Catalogue of Air Pumps and Condensers

Send for Special Circular on Automatic Exhaust Relief Valves.



KNOWLES IMPROVED POWER AIR PUMP AND JET CONDENSER.

FOR STEAM ENGINES.

65 A.

KNOWLES PATENT
COMBINED AIR AND CIRCULATING PUMPS.

THIS special combination of Air Pump with Circulating Pump is one of the most compact and economical arrangements for surface condensers of stationary engines or marine engines. The principal builders of surface condensers in this country use these pumps exclusively, and they are to be found in many of the largest electric light and power plants, where the surface system of condensers is employed.

The engraving on opposite page shows the water cylinder provided with a by-pass valve for regulating the amount of circulating water where its temperature varies with the season of the year, as is usually the case. This valve is attached to pumps of the size illustrated and larger sizes. The air cylinders of ALL sizes are provided with a priming-valve at each end (as shown) for sealing the suction valves and priming the pump.

These pumps are composition fitted throughout, in the same manner as described in the four preceding pages.

TABLE OF SIZES, ETC.

Steam Cyl.	Air Cyl.	Water Cyl.	Stroke	Steam Pipe	Exha'st Pipe	Suction of Air Cyl.	Disc'ge of Air Cyl.	Suction of Water Cyl.	Disc'ge of Water Cyl.	Price.	Telegraphic Code Word
Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches		
3¼	3½	3½	4	½	¾	1½	1	1½	1		Hardy
3½	4	4	4	½	¾	2	1½	2	1½		Haricot
4	5	5	5	½	¾	2	1½	2½	2		Harier
4½	5½	5½	6	½	¾	2½	2	3	2½		Hariff
5½	5½	5½	7	¾	1	3	2½	3	2½		Harlock
5½	6	6	7	¾	1	3	2½	3½	3		Harlot
6	8	8	7	¾	1	4	3	4	3½		Harmonic
7½	8	8	10	1	1¼	4	3½	5	4		Harmost
8	9	9	10	1	1¼	4	3½	5	4		Harness
8	10	10	12	1	1¼	5	4	6	5		Harpax
10	12	12	12	1¼	1½	5	4	8	6		Harper
12	14	14	12	2	2½	6	5	10	8		Harping
12	14	14	16	2	2½	6	5	10	8		Harrow
14	16	16	16	2½	3	8	6	10	10		Harshly
16	16	18	18	2½	3	8	6	12	10		Harslet
16	18	18	18	2½	3	10	8	12	10		Harvest
ALSO PATTERNS FOR LARGER SIZES, AND OTHER COMBINATIONS.											

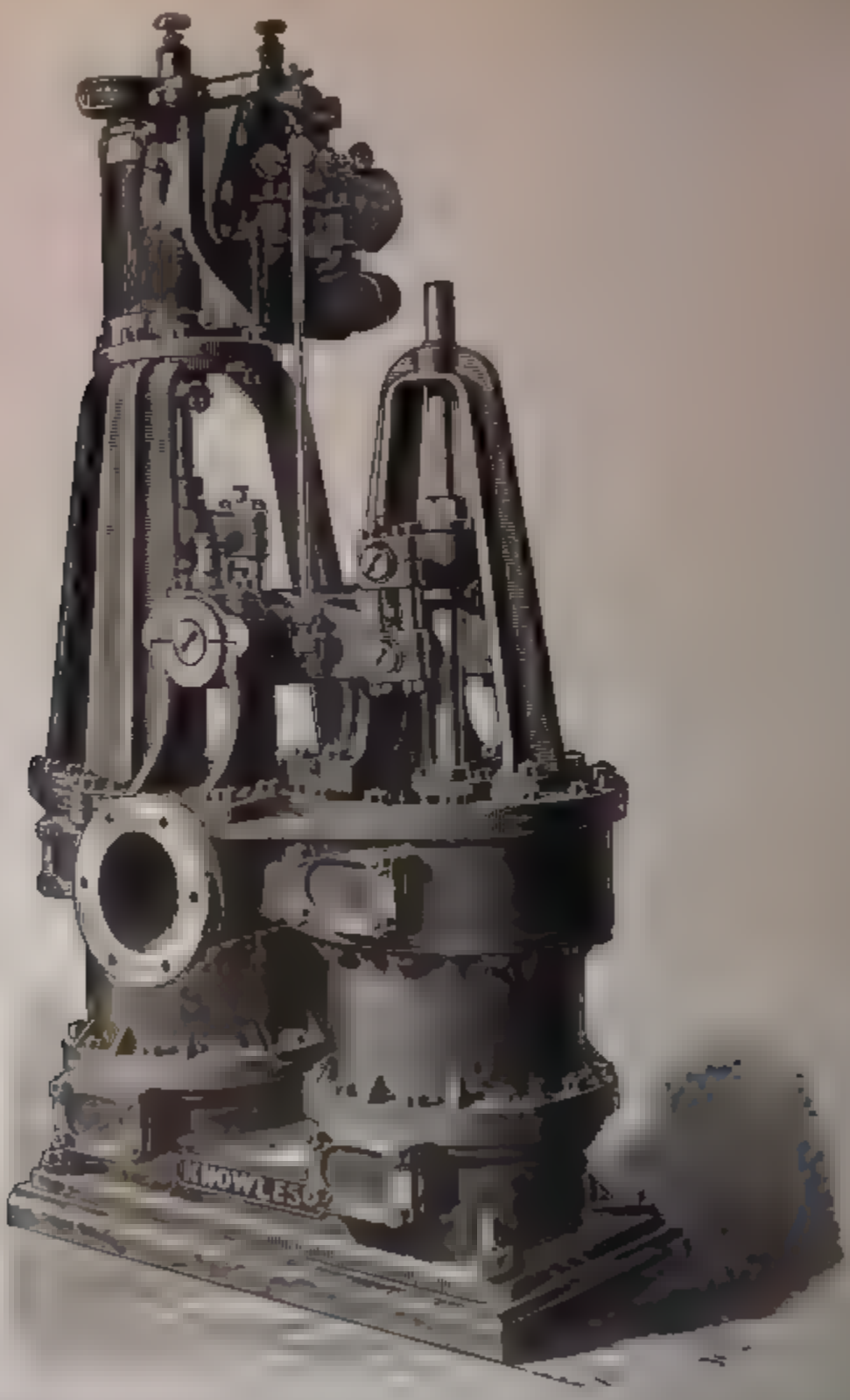
BOILER-FEED AND BILGE PUMPS ATTACHED WHEN REQUIRED.

We also arrange our Combined Air and Circulating Pumps, when desired, with compound steam cylinders for the medium and larger sizes.

Vertical Combined Air and Circulating Pumps to order; send for particulars.

SURFACE CONDENSERS.

When desired, we furnish, in connection with our COMBINED AIR and CIRCULATING PUMPS, Surface Condensers of the well-known WHEELER-ADMIRALTY and WHEELER-STANDARD make, arranged with either cylindrical or rectangular shells.



KNOWLES PATENT VERTICAL SINGLE-ACTING AIR PUMP

FOR SURFACE CONDENSERS ETC

The engraving above represents a pump having one 10-inch double acting steam cylinder two (2) single-acting air cylinders and 6-inch stroke

KNOWLES PATENT

VERTICAL SINGLE-ACTING AIR PUMP.

FOR SURFACE CONDENSERS, ETC.

THIS novel and very efficient design of Vertical Air Pump, combining a double-acting steam cylinder with two single-acting air cylinders, as illustrated on the opposite page, is of special importance where floor space is limited and high vacuum desired for the least expenditure of power. It has many other advantages that recommend it for marine service, such as simplicity, compactness, quiet running and wide range of speed and capacity.

The air cylinders are of the well-known vertical single-acting type, with foot, head and bucket valves, all accessible through conveniently located hand-holes. By means of the working beams, links and rods, connecting the air buckets and steam piston, a proper balance is established, consequently there is a uniform and smooth action throughout. There being two buckets, the discharge of water and air is continuous.

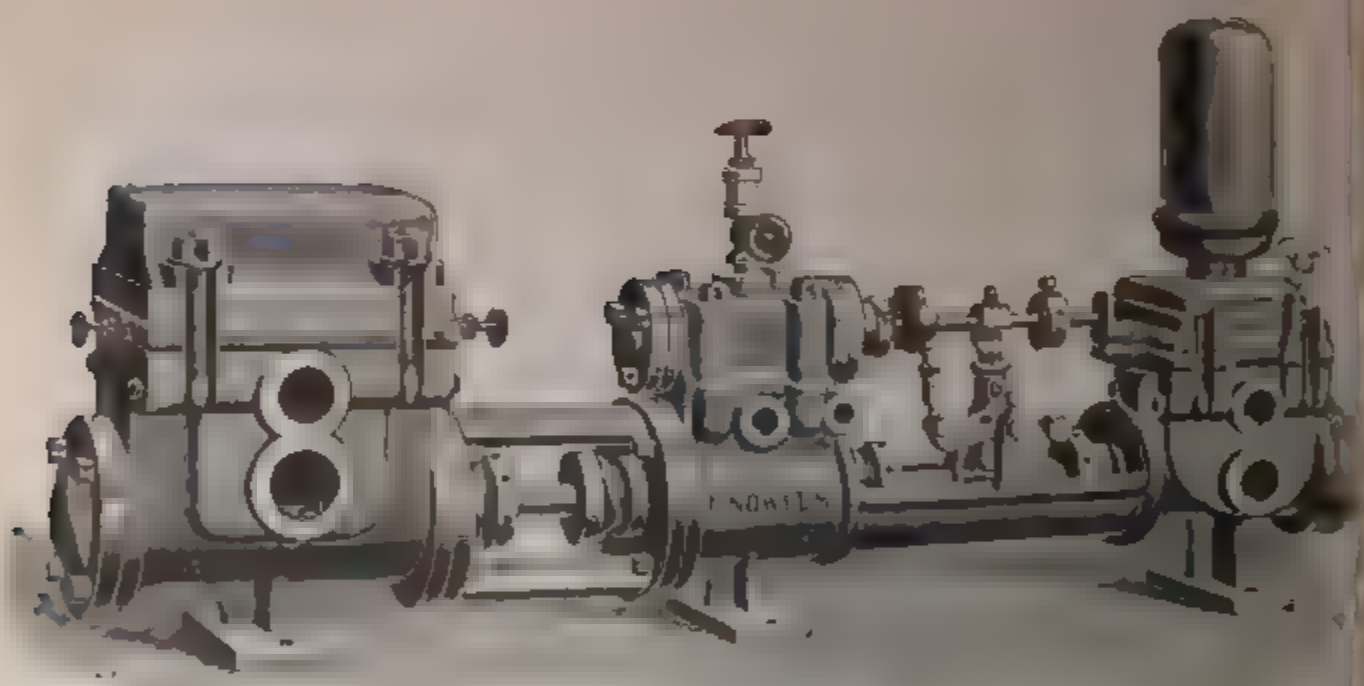
TABLE OF SIZES, ETC.

AIR PUMP							*Capacity, i.e., Weight of Steam used per Hour in Main Engine	Price	Telegraphic Code Word
Steam Cylinder	Air Cylinder	Stroke	Steam Pipe	Exhaust Pipe	*Suction Pipe	Discharge Pipe			
Inches	Inches	Inches	Inches	Inches	Inches	Inches	Pounds		
6	10	8	¾	1	5	5	7800		Halogen
7	12	10	1	1¼	6	6	14100		Halosel
9	15	10	1¼	1½	7	7	22000		Halse
9	16½	10	1¼	1½	7	7	26700		Halter
10	17½	10	1¼	1½	8	8	32000		Halting
12	20	12	2	2½		10	47000		Halymate
14	22	15	2	2½		10	57000		Hamate
16	25	18	2½	3		12	73500		Hamble
ALSO PATTERNS FOR LARGER SIZES AND OTHER COMBINATIONS.									

* Note.—If desired the suction nozzles can be arranged rectangular in shape instead of round, at a slight additional expense.

The double-acting steam cylinder is especially designed for the purpose of being operated with our latest improved valve gear, which is perfectly positive at all speeds, and provided for ready adjustment for proper length of stroke, even while the pump is running.

The air cylinders are of cast-iron lined with composition, and the buckets (either of composition or cast-iron, as may be desired) are packed with adjustable fibrous packing, held in place by composition followers, etc. The valves are of specially vulcanized rubber and work on composition seats; valve bolts also of composition; valve springs of phosphor-bronze.



KNOWLES PATENT COMBINED AIR AND BOILER FEED PUMP

FOR STEAM YACHTS, LAUNCHES, TUGS, ETC.

The engraving above represents a pump having 4 inch steam cylinder, 5 inch air cylinder, [illegible] stroke.

KNOWLES PATENT

COMBINED AIR AND BOILER-FEED PUMPS.

FOR STEAM YACHTS, LAUNCHES, TUGS, ETC.

E furnish a great many of these Combined Air and Boiler-feed Pumps for out-board pipe condensers, commonly used on small steam yachts and launches. steam cylinder drives both the air and feed pumps, as shown in the engraving site. This makes a very compact and economical arrangement. The air cyl- r draws the water of condensation from the condenser and discharges the same the hot-well filter-tank, from which it is taken by the feed-water cylinder and d into the boiler.

Both the air cylinder and feed-water cylinder have their linings, piston-rods, -seats, valve-bolts, and pistons made of composition. The valves of air der are specially vulcanized rubber, and the valves of water cylinder are of osition or hard rubber, as preferred; valve-springs of phosphor-bronze; the ns are packed with adjustable fibrous packing. The air cylinder is provided a priming valve at each end, as shown in the engraving.

TABLE OF SIZES, ETC.

Air Cyl.	Feed-water Cylinder	Stroke	Steam Pipe	Exha'st Pipe	Suction of Air Cyl.	Disc'ge of Air Cyl.	Suction of Feed Cyl	Disc'ge of Feed Cyl.	Price	Telegraphic Code Word
Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches		
3	1¼	3	¼	⅜	1	¾	½	⅜		Hashed
3½	1¼ to 1½	3	¼	⅜	1½	1	¾	½		Hassock
3½	1¼ to 1¾	4	½	¾	1½	1	1¼	1		Haster
4	1¼ to 1¾	4	½	¾	2	1½	1¼	1		Hasting
5	1¼ to 2	5	½	¾	2	1½	1¼	1		Hatband
5½	1½ to 2½	7	¾	1	2½	2	2	1½		Hatbox
6	1½ to 2½	7	¾	1	3	2½	2	1½		Hatcase
8	2 to 2¾	7	¾	1	3½	3	2	1½		Hatchel
8	2½ to 3¾	10	1	1¼	4	3½	2	1½		Hatchway
9	2½ to 3¾	10	1	1¼	4	3½	2	1½		Hateless
10	2½ to 3¾	12	1	1¼	5	4	2	1½		Hatter

ALSO PATTERNS FOR LARGER SIZES AND OTHER COMBINATIONS.

Vertical Combined Air and Boiler-feed Pumps, both single-acting and double-g pattern. Particulars on application.

N B.—An excellent way to connect the feed-water cylinder of these pumps is to run a small om the discharge of the feed-pump to the hot-well or filter-tank, with a valve on said pipe to te the amount of water that is allowed to flow back to the tank The suction pipe should o valve on it, so as not to prevent the free flow of water from the tank to feed-pump, and nable the water cylinder to *completely* fill at each and every stroke. By this arrangement mp runs smoothly, and hot vapors cannot accumulate and prevent the proper working of the -valves The amount of water fed to the boiler is regulated by the valve on the *discharge*-ending to the tank the wider open this valve is set, the greater the quantity of water flowing o the tank, and, consequently, the less fed to the boiler.

KNOWLES PATENT
HORIZONTAL DOUBLE-ACTING AIR PUMP.

FOR SURFACE AND KEEL CONDENSERS, ETC.

THE advantage of independent air pumps for marine and other steam engines is so well recognized that it is hardly necessary to say much on the subject here, except to mention the fact that the most modern practice is to have no pumps attached to the engine, thus relieving it from the drag or load of auxiliary connections of any kind. The advantage of forming a vacuum for the engine before the latter is started is greatly in favor of the independent system of air pumps; the speed of the pump can also be regulated to the requirements of the engine.

TABLE OF SIZES, ETC.

Steam Cylinder	Air Cylinder	Stroke	Steam Pipe	Exhaust Pipe	Suction Pipe	Delivery Pipe	Price	Telegraphic Code Word
Inches	Inches	Inches	Inches	Inches	Inches	Inches		
3	3½	3	¼	⅜	1½	1		Hairhung
3¼	4	4	½	¾	2	1½		Hairlace
3½	4½	4	½	¾	2	1½		Hairless
4	5	5	½	¾	2	1½		Haketin
4	6	7	½	¾	3	2½		Hakat
5½	7	7	¾	1	3	2½		Haler
5½	8	7	¾	1	3½	3		Halesia
6	8	10	¾	1	4	3½		Halfen
6	9	10	¾	1	4	3½		Halimas
6	10	12	¾	1	5	4		Haling
8	12	12	1	1¼	5	4		Halitus
8	14	12	1	1¼	6	5		Hallage
10	14	12	1¼	1½	6	5		Halliard
10	14	16	1¼	1½	6	5		Hallite
10	16	16	1¼	1½	8	6		Halloide
12	18	18	2	2½	10	8		Halloo
12	20	24	2	2½				Haloed

ALSO PATTERNS FOR LARGER SIZES AND OTHER COMBINATIONS OF CYLINDERS.

The linings, piston-rods, valve-seats and valve-bolts of the air cylinders are made of the best composition. The air pistons are also of composition packed with adjustable fibrous packing, and the valves are made of the best quality of rubber, specially vulcanized for the purpose; valve-springs of phosphor-bronze.

We also make Vertical Air Pumps of the double-acting type—particulars on application.

For Vertical Air Pumps of the single-acting type, see pages 58 and 59.

KNOWLES PATENT
CIRCULATING PUMPS.

FOR SURFACE CONDENSERS,

ALSO FOR WRECKING, BILGE AND BALLAST SERVICE.

THE table below gives a list of pumps, the cylinders of which are specially proportioned for circulating water through surface condensers, for wrecking, bilge and ballast service and similar light work.

The water cylinders are provided with composition linings reaching from head to head; the water-pistons are composition, packed with adjustable fibrous packing; the piston rods are also of composition; valves of the best quality rubber, specially vulcanized for the purpose; valve-seats of composition, valve-bolts of composition and valve-springs of phosphor-bronze.

TABLE OF SIZES, ETC.

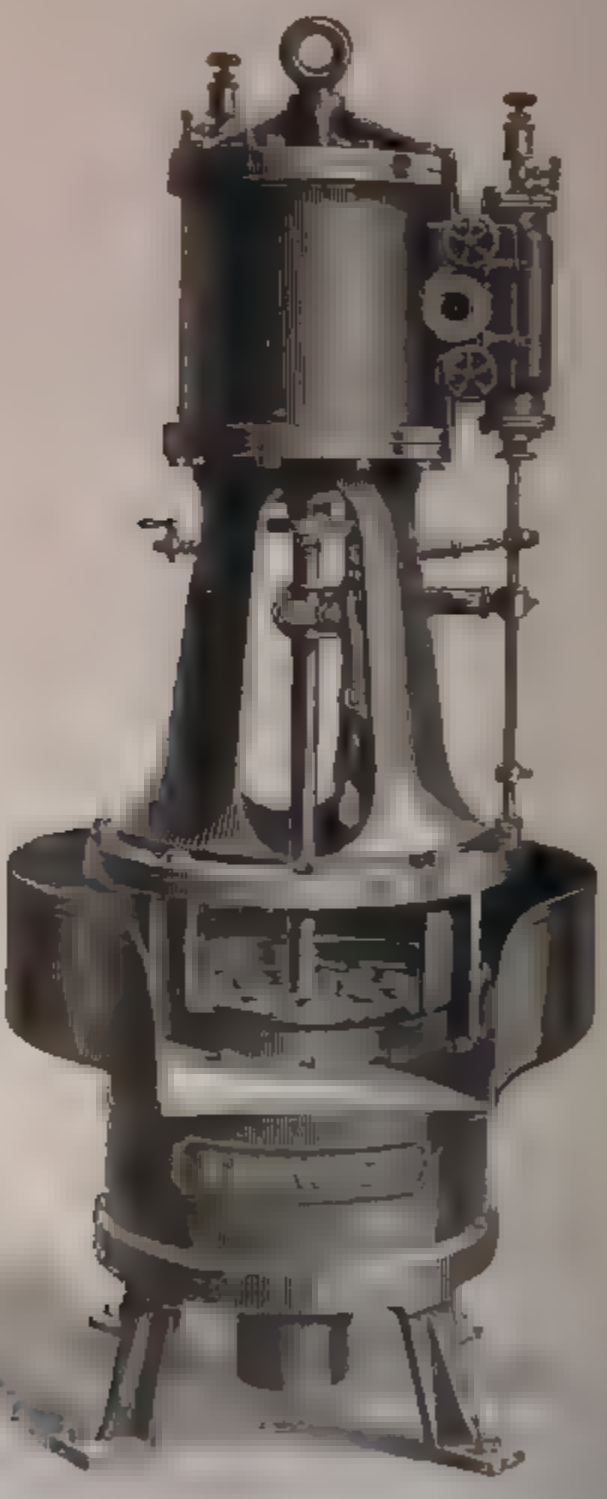
Steam Cylinder	Water Cylinder	Stroke	Gallons per Stroke	*Capacity per Minute at Ordinary Speed	Steam Pipe	Exhaust Pipe	Suction Pipe	Delivery Pipe	Price	Telegraphic Code Word
Inches	Inches	Inches	Inches	Gallons	Inches	Inches	Inches	Inches		
3	3½	3	.13	13	¼	⅜	1½	1		Hammel
3	4	3	.16	16	¼	⅜	1½	1		Hammock
3¼	4	4	.22	22	½	¾	2	1½		Hamous
4	5	5	.43	43	½	¾	2½	2		Hamper
4	6	7	.87	87	½	¾	3½	3		Hances
5½	7	7	1.16	116	¾	1	4	3½		Handball
5½	8	7	1.52	152	¾	1	4	3½		Handbook
5½	8	10	2.20	220	¾	1	5	4		Handed
6	9	10	2.75	275	¾	1	5	4		Handfast
6	10	12	4.08	408	¾	1	6	5		Hangby
8	12	12	5.87	587	1	1¼	8	6		Hangdog
8	14	12	8.00	800	1	1¼	10	8		Hangnail
10	14	12	8.00	800	1¼	1½	10	8		Hanker
10	14	16	10.67	800	1¼	1½	10	8		Hansel
10	16	16	13.92	1044	1¼	1½	10	10		Happen
12	18	18	19.83	1322	2	2½	12	10		Happily
12	18	24	26.44	1322	2	2½				Harbor
14	20	24	32.64	1632	2½	3				Harden
14	22	24	39.50	1975	2½	3				Hardish
16	24	24	47.00	2350	2½	3				Hardock

ALSO PATTERNS FOR LARGER SIZES AND OTHER COMBINATIONS OF CYLINDERS.

* The capacities given in this column are figured at a speed of 100 feet piston travel per minute, for pumps of 12-inch stroke and over. Pumps under 12-inch stroke are figured at 100 single strokes per minute for ordinary speed.

For salt water service, in the larger pumps (*i.e.*, size 5½x8x10 and over) the valves work on plates of composition, instead of the ordinary brass seats driven or screwed into iron castings, which is an important feature.

We also have patterns for VERTICAL PUMPS, which are very convenient where space is limited, as is often the case in the engine-rooms of steam vessels.



KNOWLES PATENT WRECKING PUMP.

Vertical Single Acting Pattern

52

KNOWLES PATENT

VERTICAL WRECKING PUMPS.

(SPECIAL SINGLE-ACTING PATTERN)

ALSO, FOR DRAINAGE AND IRRIGATING SERVICE.

THIS special design of the Knowles Vertical Pump is a very convenient and inexpensive form of pump for Wrecking, Drainage or Irrigating purposes. These pumps are largely used by the Wrecking Companies the Sea Coast and Lake Service; on the lower Mississippi River they are used for draining bottom lands, etc. ey are light, portable, and have great pumping capacity. They are single-acting, but the flow of water from pumps is practically constant, as the peculiar design and operation of pumps gives this effect. These pumps ll handle large quantities of water with greater economy than centrifugal pumps, while they are much simpler d less likely to get out of order. They will not grind out and lose their suction power, causing excessive ppage, but will fully discharge their correct theoretical capacity of water at *any* speed—an impossibility with ntrifugal and similar pumps. It has been demonstrated from trials made by well-known authorities that ntrifugal pumps do not deliver the same quantity of water per revolution at different speeds.

A full and comparatively long stroke with an even, smooth motion on the *up* as well as on the *down* stroke e special features of the Knowles Vertical Wrecking Pumps. The steam cylinder is *positive* and does not quire any lever or other hand gear to work it "off the center." There are no belts to slip or complicated echanism to get out of order.

These pumps are simply "lift" pumps and are not designed to elevate water above their discharge ozzles, but they will draw water any distance within the limit of "suction" power.

SIZES, CAPACITIES AND PRICES:

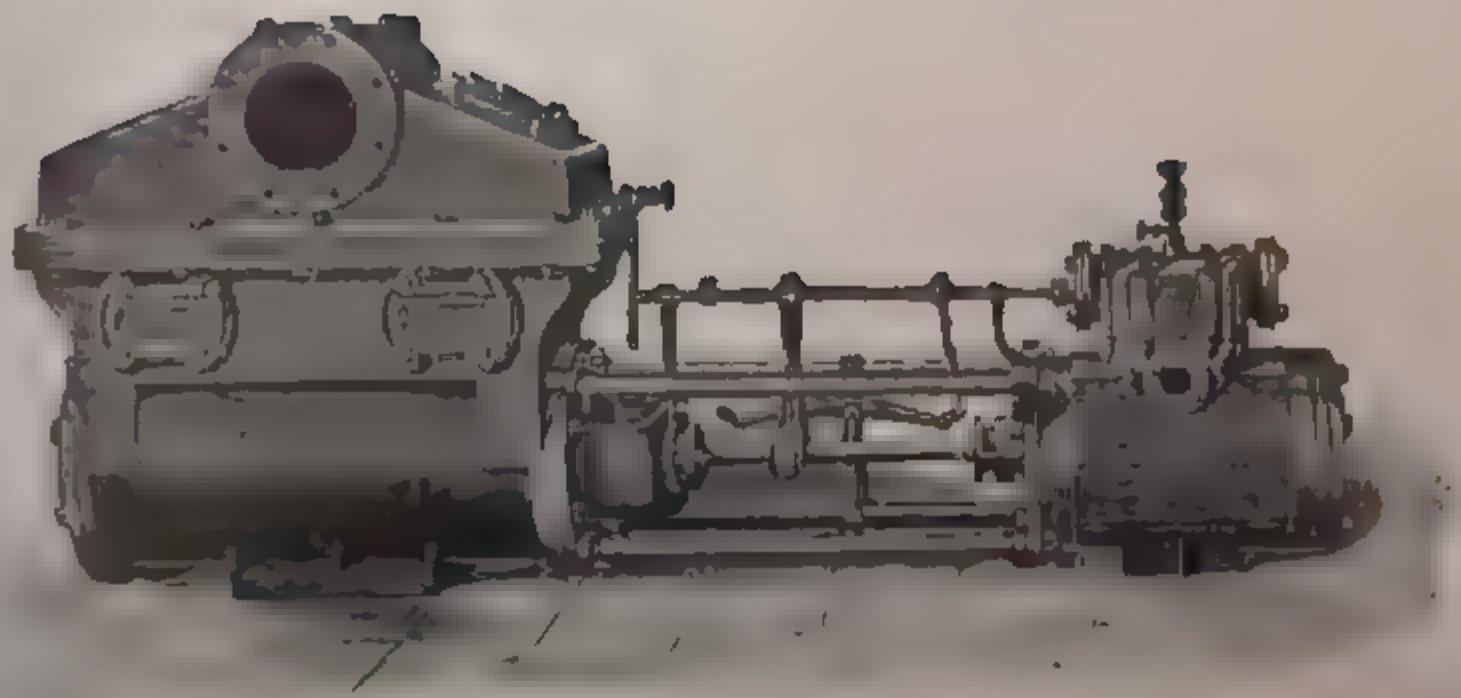
Steam Cylinder. Inches.	Water Cylinder. Inches.	Stroke. Inches.	* Capacity per Minute at Ordinary Speed.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipe. Inches.	Price.
6	12	10	350 to 440 Gals	¾	1	6	
10	20	12	1000 " 1300 "	1¼	1½	10	
14	25	12	1400 " 1875 "	2	2½	12	
16	27	12	1600 " 1875 "	2½	3	12	
18	30	10	1800 " 2000 "	2½	3	14	
18	30	16	2000 " 2700 "	2½	3	14	
18	33	16	2200 " 3700 "	2½	3	16	

ALSO PATTERNS FOR LARGER SIZES AND OTHER COMBINATIONS OF CYLINDERS.

* The capacities given in this column are figured at the moderate speed of about 120 to 150 feet piston travel per minute.

The water cylinder is lined with brass; the valve seats, etc., are also of brass. The piston rods are brass covered, so that these pumps are adapted for salt as well as fresh water. Valves of best vulcanized rubber are used, with the largest area possible to pass obstructions.

HORIZONTAL PUMPS, for WRECKING, DRAINAGE or IRRIGATING, see page 61-A



KNOWLES PATENT VACUUM PUMP.

DIRECT-ACTING PATTERN.

KNOWLES PATENT

VACUUM PUMPS.

Direct-Acting Pattern.

e in sugar refineries, plantation sugar houses, for condensed milk factories, glue factories, and ll kinds of apparatus used in concentrating extracts, chemicals, etc., these Improved Direct- uum Pumps are especially adapted. They combine all the latest improvements, and are simple, d very reliable. The workmanship and materials used in their construction is of the *best* char- rability and freedom from accident or expensive repairs, are prominent features They occupy om and do not require expensive foundations, being self-contained. They can be transported ing taken apart, and there is but little expense necessary to connect them. They are adapted ll to the "dry" as to the "wet" system, and will maintain a first class vacuum.

SIZES AND PRICES.

Air Cylinder. Inches.	Stroke. Inches.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipe. Inches.	Delivery Pipe. Inches.	Price.	REMARKS.
5	7	½	¾	3	3		
8	12	¾	1	5	5		
10	10	1	1¼	5	5		
10	12	1	1¼	6	6		
11	12	1	1¼	6	6		
12	16	1¼	1½	7	7		
14	16	1¼	1½	8	8		
16	16	2	2½	8	8		
18	24	2½	3	8	8		
20	24	2½	3	10	10		
22	24	2½	3	10	10		
24	24	3½	4	14	14		

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

valve seats, valve bolts, lining, piston rod and stuffing-boxes of the air cylinder are made of the best l composition. On the inside head of the air cylinder is provided a water-basin arranged so that the fing-box is always sealed with water, thus preventing any possible leak of air through the gland to e the vacuum when the pump is in operation.

DOUBLE VACUUM PUMPS.

e pumps have two air cylinders, arranged with the steam cylinder between them. The pumps are particularly for "double" or "triple effects," where one air cylinder is connected with the condenser of ke" pan, and the other air cylinder to the condenser of the last pan of the "double" or "triple effect."

SIZES AND PRICES:

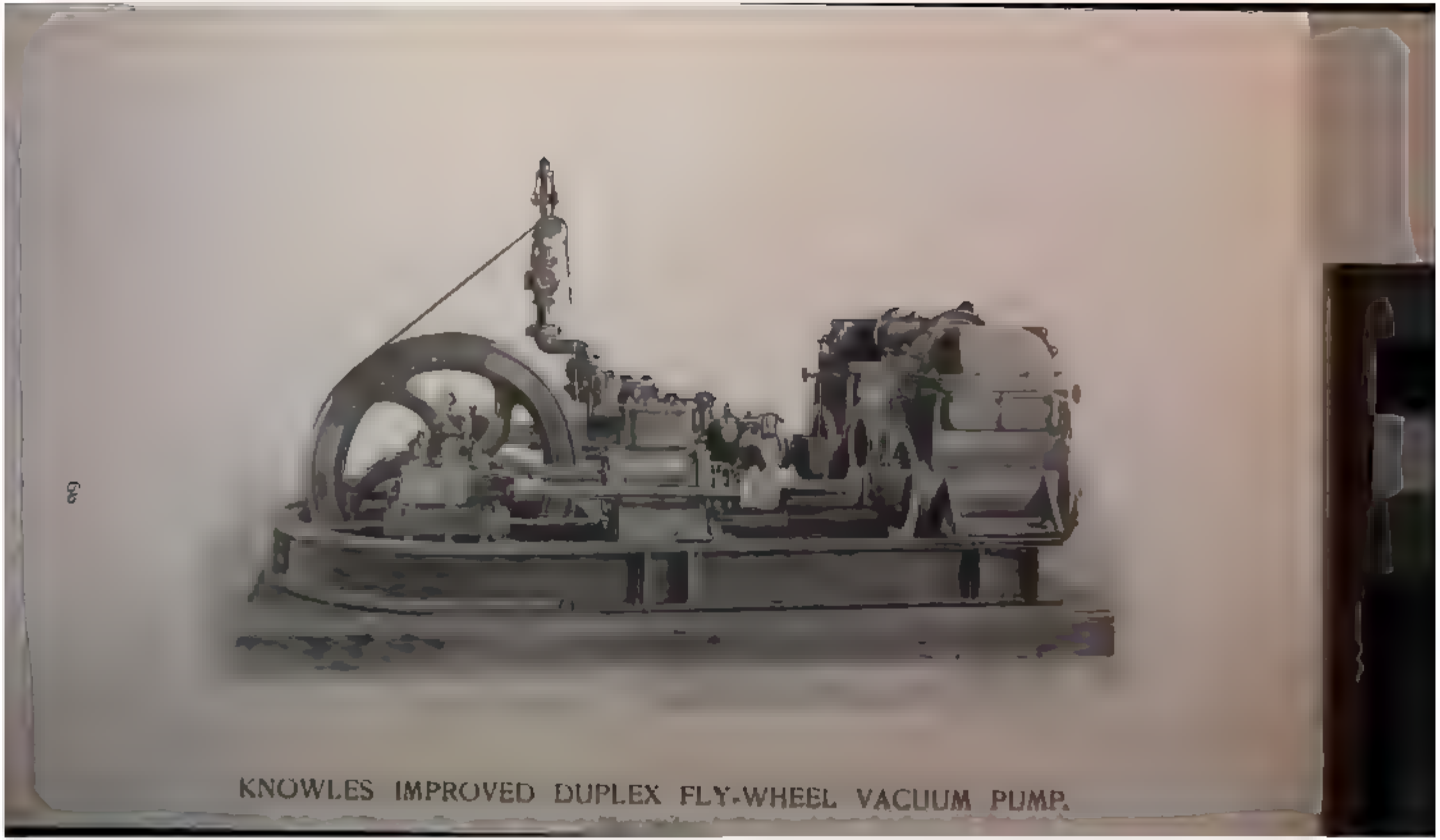
er.	Air Cylinder For Strike Pan Condenser. Inches.	Air Cylinder for "Effect" Condenser. Inches.	Stroke. Inches.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipes. Inches.	Delivery Pipes. Inches.	Price.
	16	16	16	2½	3	8	8	
	18	18	24	3½	4	8	8	
	20	20	24	4	4½	10	10	
	22	22	24	4	4½	10	10	
	24	24	24	4	4½	12	12	

ALSO PATTERNS FOR SMALLER AND LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

air cylinders have gun-metal composition linings, valve seats, valve bolts, piston rods and stuffing-boxes. gement of water-basins for sealing the air cylinder stuffing-boxes are the same as in the above.

IK AND FLY-WHEEL VACUUM PUMPS, see next two pages also page 70.

MIXED VACUUM AND WATER PUMPS, see pages 68, 69, and 71.



KNOWLES IMPROVED DUPLEX FLY-WHEEL VACUUM PUMP.

KNOWLES IMPROVED

DUPLEX FLY-WHEEL VACUUM PUMP.

THE cut on the opposite page shows our latest pattern Duplex Fly-Wheel Vacuum Pump. Owing to their perfectly uniform and positive length of stroke and consequent small clearance space in both steam and vacuum cylinders, these pumps are most efficient, both in producing high vacuum and in economy in steam consumption.

They are made in the most thorough manner and of the best materials. The Air Cylinders are lined with gun-metal composition. The piston rods, valve seats, and valve bolts are also of composition. The pistons of the Air Cylinders are of composition, packed with a special form of adjustable packing. The steam cylinders have plain D slide valves. The connecting rods, crossheads, and crank shaft are of the best forged iron. Each and every detail is carefully designed and adjusted for the best service. The cranks are set at right angles, consequently there is no "*dead centre*" and the motion is steady and uniform at any speed.

The design of our new pattern vacuum cylinder is such that the same pump may be used equally well for either the wet or dry system.

In the "wet system," all the water used for condensing passes through the pump, while in the "Dry System," the "Barometrical column" or leg pipe carries off the injection water by gravity from the bottom of the condenser without passing through the pump.

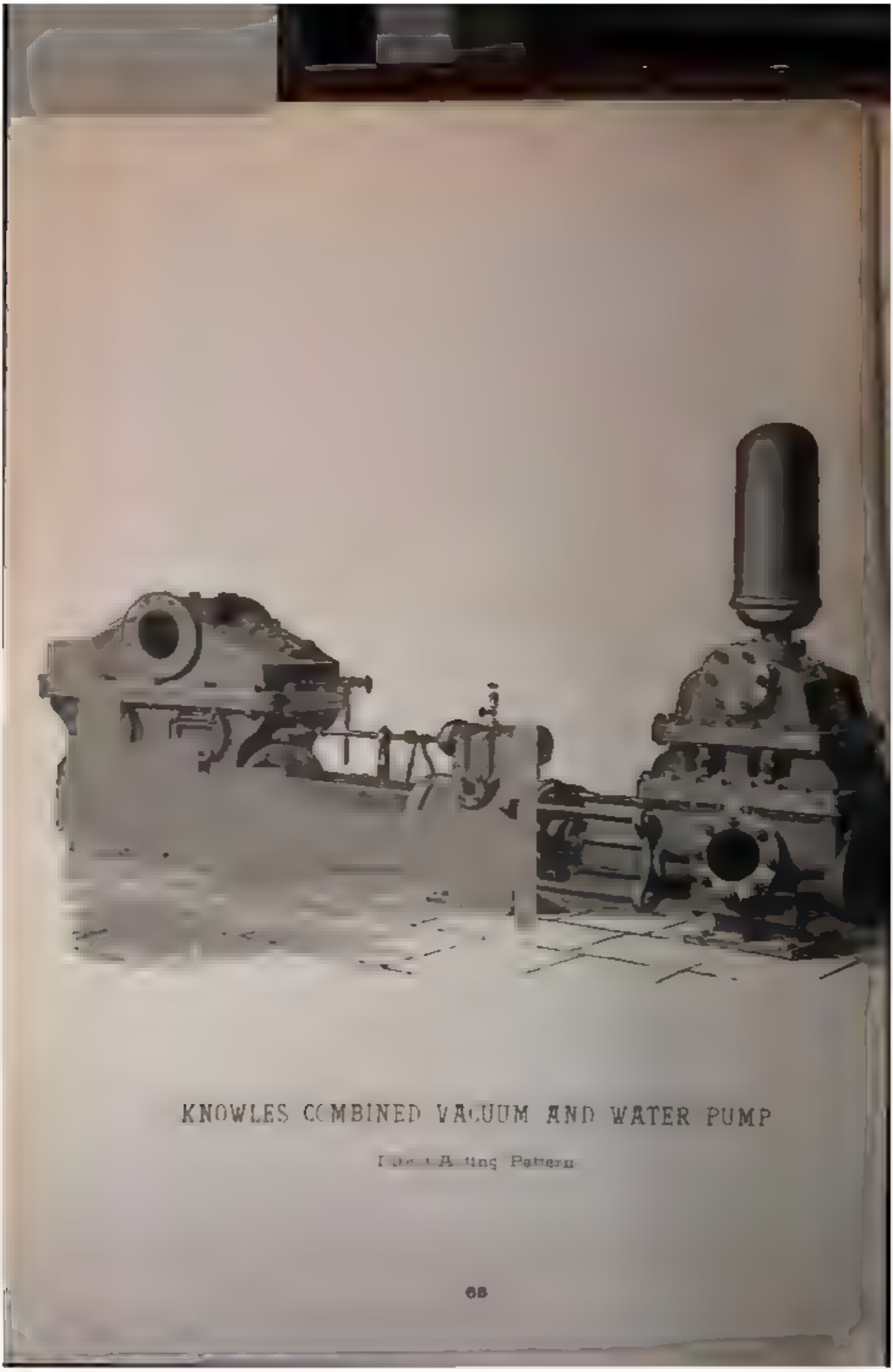
LIST OF SIZES, ETC.

Steam Cylinder	Vacuum Cylinder	Stroke	Steam Pipe	Exhaust Pipe	Suction Pipe	Discharge Pipe	Length	Width	Height	Telegraphic Code Word.
5	6	6	1	1½	5	5	85	45	40	Feague
6	8	6	1	1½	5	5	90	48½	40	Fealty
7	10	6	1	2	6	6	95	50¾	42	Fearful
8	11	6	1	2	6	6	95	51¾	45	Fearless
8	13	10	1	2½	6	6	128½	60	56	Feaster
8	12	10	1	2½	6	6	128½	60	56	Feasting
8	14	10	1	2½	8	6	134	63	54	Feathered
9	12	10	1	2½	6	6	128¼	60	60	Feathery
9	14	10	1	2½	8	6	132½	67	51	Featness
10	14	10	1	2½	8	6	132½	67	63	Featured
10	16	10	2	3	10	8	136	82½	47	Feaze
12	17	10	2	3	10	8	136	82½	47	Febrific
12	18	10	2	3	12	10	136	82¼	47	Febrifuge
12	20	10	2	3	12	10	154	101	51	Febrile
14	18	10	2	3	12	10	136	82	54	Fecial
14	20	10	2	3	12	10	154	101	44	Fecula
14	22	10	2	3	12	10	136	86½	44	Feculent
15	22	10	2½	3½	12	10	151½	86½	55	Fecund
15	24	10	2½	4	12	10	172	92½	44	Fecundate

ALSO LARGER SIZES AND OTHER COMBINATIONS OF CYLINDERS.

The Governor shown in the cut is supplied only when ordered—at a slight additional expense

☞ **Parties Ordering** will please inform us (1) if the vacuum pump is for "Wet" or "Dry" System and (2) what is the diameter of the Pan or Evaporator and the amount of heating surface in same; (3) what is the character of the material and quantity to be evaporated per hour in the evaporator, and (4) the average temperature of the injection water for the condenser.



KNOWLES COMBINED VACUUM AND WATER PUMP

[illegible] A ting Pattern

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KNOWLES IMPROVED

DUPLEX FLY-WHEEL VACUUM PUMP.

THE cut on the opposite page shows our latest pattern Duplex Fly-Wheel Vacuum Pump. Owing to their perfectly uniform and positive length of stroke and consequent small clearance space in both steam and vacuum cylinders, these pumps are most efficient, both in producing high vacuum and in economy in steam consumption.

They are made in the most thorough manner and of the best materials. The Air Cylinders are lined with gun-metal composition. The piston rods, valve seats, and valve bolts are also of composition. The pistons of the Air Cylinders are of composition, packed with a special form of adjustable packing The steam cylinders have plain D slide valves. The connecting rods, crossheads, and crank shaft are of the best forged iron. Each and every detail is carefully designed and adjusted for the best service. The cranks are set at right angles, consequently there is no "*dead centre*" and the motion is steady and uniform at any speed.

The design of our new pattern vacuum cylinder is such that the same pump may be used equally well for either the wet or dry system.

In the "wet system," all the water used for condensing passes through the pump, while in the "Dry System," the "Barometrical column" or leg pipe carries off the injection water by gravity from the bottom of the condenser without passing through the pump.

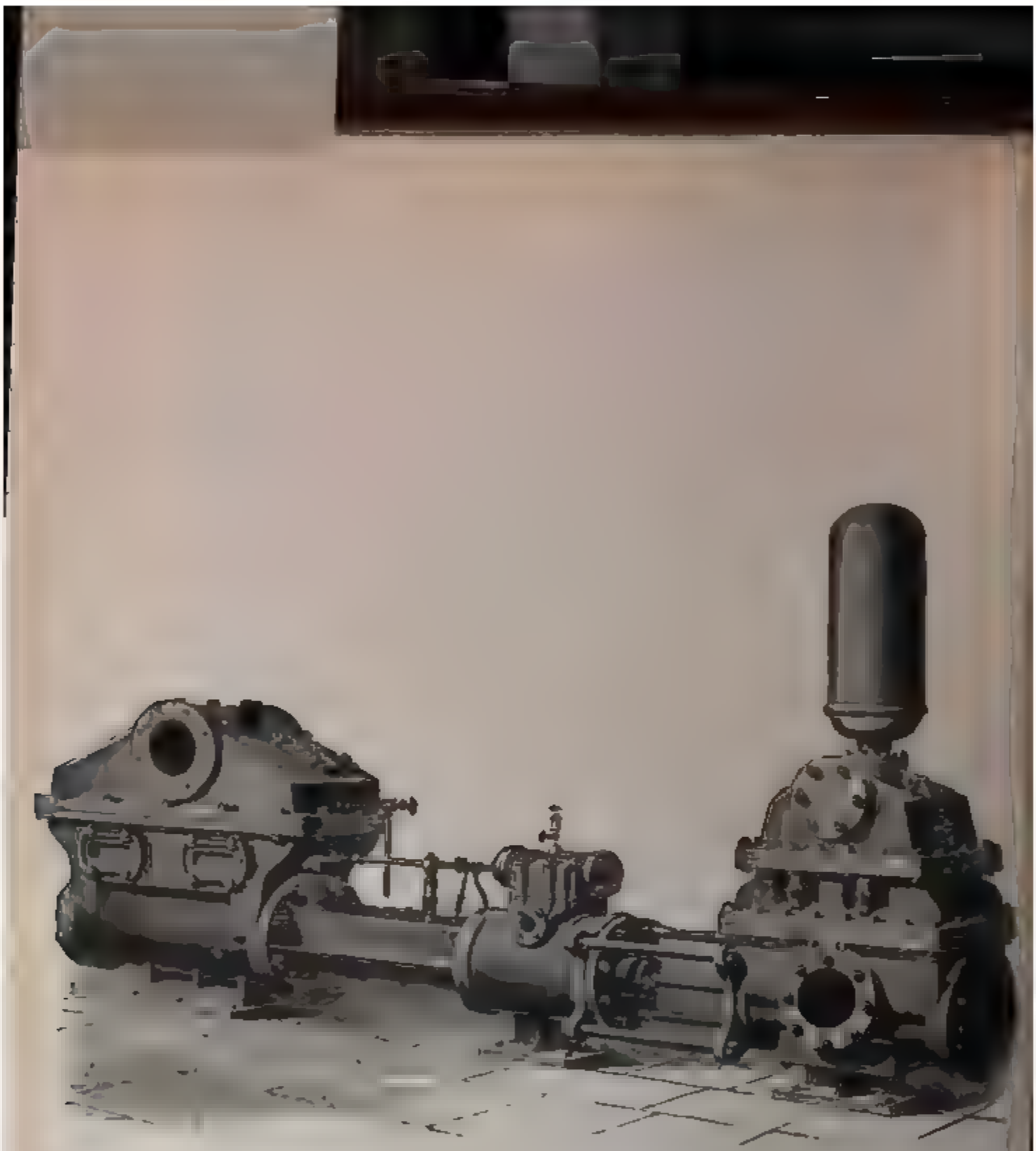
LIST OF SIZES, ETC.

Steam Cylinder	Vacuum Cylinder	Stroke	Steam Pipe	Exhaust Pipe	Suction Pipe	Discharge Pipe	Length.	Width	Height	Telegraphic Code Word.
5	6	6	1	1½	5	5	85	45	40	Feague
6	8	6	1	1½	5	5	90	48½	40	Fealty
7	10	6	1¼	2	6	6	95	50¾	42	Fearful
8	10	6	1¼	2	6	6	95	51¾	45	Fearless
8	10	10	1¼	2½	6	6	128¾	60	56	Feaster
8	12	10	1¼	2½	6	6	128⅞	60	56	Feasting
8	14	10	1¼	2½	8	6	134	63	54	Feathered
9	12	10	1½	2½	6	6	128¾	60	60	Feathery
9	14	10	1½	2½	8	6	132½	67	51	Featness
10	14	10	1½	2½	8	6	132½	67	63	Featured
10	16	10	2	3	10	8	136	82½	47	Feaze
12	16	10	2	3	10	8	135	82½	47	Febrific
12	18	10	2	3	12	10	130	82½	47	Febrifuge
12	20	10	2	3	12	10	154	101	51	Febrile
14	18	10	2	3	12	10	136	82½	54	Fecial
14	20	10	2	3	12	10	154	101	44	Fecula
14	22	10	2	3	12	10	136	86½	44	Feculent
16	22	10	2½	3½	12	10	151½	86½	55	Fecund
18	24	10	2½	4	12	10	172½	92½	44	Fecundate

ALSO LARGER SIZES AND OTHER COMBINATIONS OF CYLINDERS

The Governor shown in the cut is supplied only when ordered—at a slight additional expense.

☞ **Parties Ordering** will please inform us (1) if the vacuum pump is for "Wet" or "Dry" System and (2) what is the diameter of the Pan or Evaporator and the amount of heating surface in same; (3) what is the character of the material and quantity to be evaporated per hour in the evaporator; and (4) the average temperature of the injection water for the condenser.



KNOWLES COMBINED VACUUM AND WATER PUMP

Direct Acting Pattern

KNOWLES PATENT

COMBINED VACUUM & WATER PUMP.

Direct-Acting Pattern.

THIS compact combination of our Improved Direct-Acting Vacuum Pump with a water pump, for use in connection with the condensing apparatus of vacuum pans, etc., has met with great success in Cuba, San Domingo, Mexico, South America, Sandwich Islands, and other sugar-growing countries. They are also largely used in the sugar plantations of the Southern States, and in the condensed-milk factories, grape-sugar refineries and glue works of the North and West. These pumps are very efficient in operation and will maintain a *steady* and high vacuum, and will operate as

PERFECTLY ON THE "WET" AS ON THE "DRY" SYSTEM.

When connected with a vacuum pan working on the "dry" system, the water cylinder of the pump is arranged to deliver the injection water to the tank that supplies the condenser, or, if preferred, to the condenser direct. In Cuba and other places where the "cooling tower" is in vogue (the injection water being used over and over again), the water cylinder is arranged to take the warm water discharged by the air cylinder * and deliver it to the "cooling tower." This is the general arrangement when working on the "wet" system.

Compactness, simplicity, strength and durability are prominent features of these pumps, while the *cost*, as compared with the usual cumbersome pumping apparatus, is considerably less. But little labor is required to erect them; heavy and expensive foundations are unnecessary. The working parts being few in number and substantial in construction, the cost of maintaining these pumps in perfect working order is comparatively a trifle.

SIZES AND PRICES:

Steam Cylinder. Inches.	Air Cylinder. Inches.	Water Cylinder. Inches.	Stroke. Inches.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Price.	REMARKS.
8	8	4½ or 5	12	1	1¼		
10	10	5 or 6	12	1¼	1½		
12	12	6 or 7	16	2	2½		
14	14	8 or 9	16	2½	3		
14	16	9 or 10	16	2½	3		
16	18	10 or 12	24	2½	3		
18	20	12 or 14	24	3½	4		
20	22	13 or 14	24	3½	4		
20	24	14 or 16	24	3½	4		

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

* A favorite way with us now is to connect the delivery nozzle of the air cylinder directly to the suction nozzle of the water cylinder by a suitable pipe, thus saving the expense and room for a hot-well tank. This pipe connection we supply at a slight additional cost.

As shown by the engraving on opposite page, the piston rod stuffing-box in the head of the air cylinder is sealed with water, thus preventing any possible leak of air through the gland to deterioriate the vacuum when pump is in operation.

The valve seats, valve bolts, linings, stuffing-boxes and piston rods of both water and air cylinders are of gun-metal composition, substantially made.

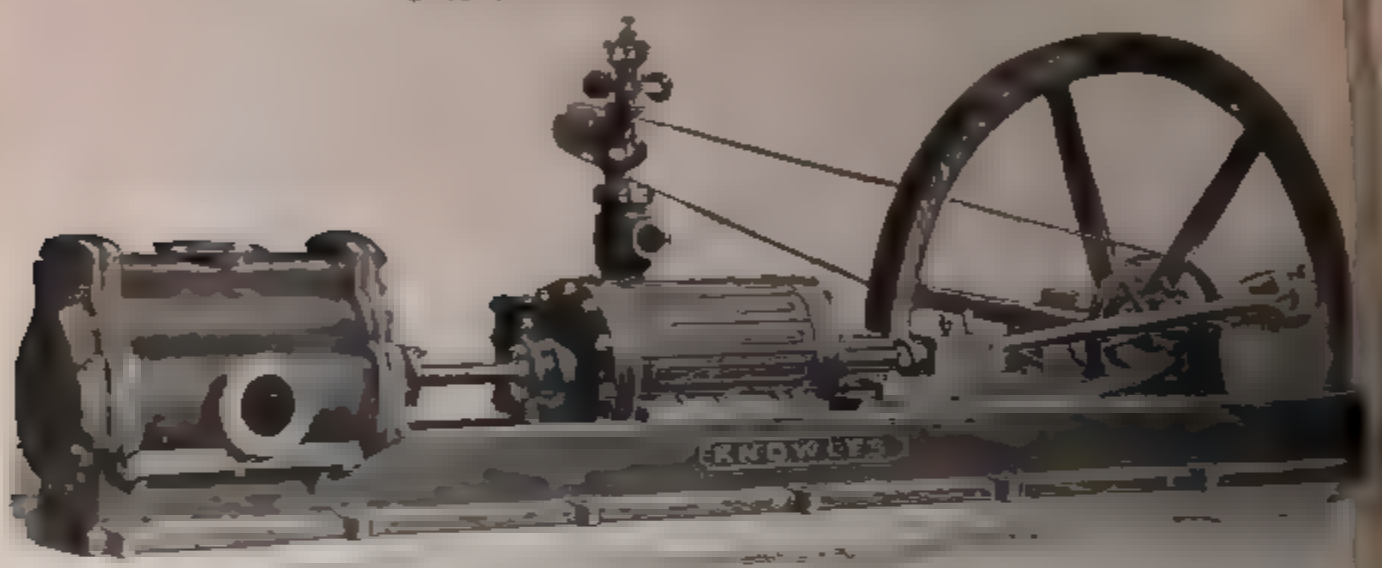
COMBINED VACUUM AND WATER PUMPS of the Crank and Fly-Wheel Pattern, see page 71.

COMBINED INJECTION AND REFRIGERATOR PUMPS and other Sugar-House Pumps, see pages 72 and 73.

KNOWLES PATENT

FLY-WHEEL VACUUM PUMPS.

SINGLE CYLINDER CRANK AND FLY-WHEEL PATTERN



THERE are many engineers who prefer Vacuum Pumps of the single cylinder long stroke crank and fly wheel pattern, considering that although more expensive in first cost, they possess certain advantages over the direct acting steam cylinder fly wheel vacuum pumps. To meet this preference, we have designed a very superior machine, as shown by the engraving above. We have a large variety of sizes of same vacuum pumps as per table below given.

SIZES AND PRICES.

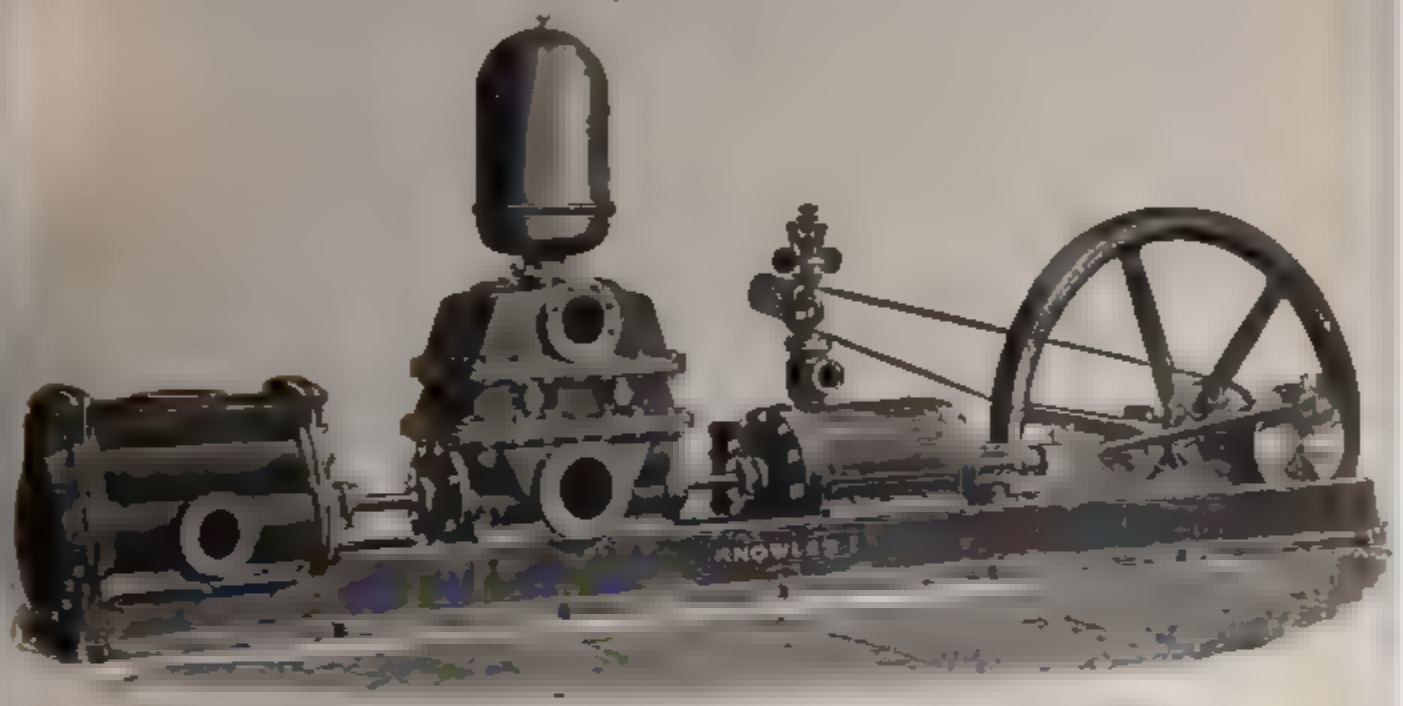
Steam Cylinder Inches	Air Cylinder Inches	Stroke Inches	Steam Pipe Inches	Exhaust Pipe Inches	Price	REMARKS
10	14	16	2½	3½		
12	16	16	3	4		
14	18	24	3½	4		
16	22	24	4	5		
16	24	24	4½	6		
18	24	24	4½	6		
20	29	24	5	7		
22	28	24	5	8		

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

The lining, valve seats, piston rod, etc., of the air cylinder, are made of composition, the piston is also made of the same material, packed with adjustable fitting packing.

KNOWLES PATENT
COMBINED VACUUM & WATER PUMPS.

CRANK AND FLY-WHEEL PATTERN.



TO meet the demand of those who have a preference for Combined Vacuum and Water Pumps made on the Crank and Fly Wheel System, we have built special patterns for a full line of sizes as will be seen by table below.

As shown by the engraving above, the steam, air and water cylinders are mounted on a substantial bed-plate. The steam cylinder is provided with all the latest improvements. The connecting rod, shaft, etc. are made of the best forged iron. The governor is adjustable to any speed desired. The air cylinder is of improved design. The water cylinder is built on our "double cup" pattern, having large valve area, etc.

SIZES AND PRICES.

Steam Cylinder Inches.	Air Cylinder Inches.	Water Cylinder Inches.	Stroke Inches.	Steam Pipe Inches.	Exhaust Pipe Inches.	Price.	REMARKS.
10	10	6	12	2½	3½		
12	12	7	16	3	4		
14	14	8	16	3½	4		
16	16	10	16	4	5		
18	18	12	24	4½	6		
20	20	13	24	4½	6		
22	22	14	24	5	7		
24	24	16	24	5	8		

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

Both air and water cylinders have composition linings, pistons, valve seats, etc. The piston rod is of steel or composition and extends from the steam piston to the air piston, passing through the water cylinder.

Vertical Combined Vacuum and Water Pumps, built on the "Working Beam" pattern, of improved form, also furnished. Full particulars on application.

KNOWLES PATENT
COMBINED INJECTION & REFRIGERATOR PUMPS.

For Plantation Sugar Houses, etc.

THIS compact and economical arrangement or combination of two water cylinders, driven by a Knowles direct-acting steam cylinder, is especially adapted to the condensing apparatus of single vacuum pans, "double" and "triple effects," where the "dry" system is used—as in Cuba, San Domingo, and other tropical countries where the water supply for condensing purposes is very limited.

The cold water cylinder elevates the injection water to the tank * that supplies the condenser, while the hot water cylinder takes the warm water (discharged by the vacuum pump) from the "hot well" tank and pumps it to the "refrigerator," or cooling-tower.

The hot water cylinder being larger than the cold water cylinder, it is impossible to overflow or flood the "hot well" tank. Besides this desirable feature, the advantage and economy of having both water cylinders directly connected to and worked by one steam cylinder is one of importance.

Both water cylinders are arranged with gun-metal composition linings, valve seats, valve bolts, piston rods, and piston rod stuffing-boxes. The valve areas are large and the water passages roomy and direct.

The cold water cylinder has the best quality of vulcanized rubber valves and gun-metal composition piston, the latter packed with fibrous packing or leather cups, as preferred.

The hot water cylinder has hard rubber or brass valves and gun-metal composition piston, the latter packed with fibrous packing or composition rings, as preferred.

SIZES AND PRICES:

Steam Cylinder. Inches.	Cold Water Cylinder. Inches.	Hot Water Cylinder. Inches.	Stroke. Inches.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipes. Inches.	Delivery of Pipes. Inches.	Price.
12	8	9	12	2	2½	6	6	
14	9	10	12	2	2½	6	6	
14	10	12	12	2	2½	8	6	
16	10	12	12	2½	3	8	6	
16	10	12	16	2½	3	8	6	
18	12	14	16	2½	3			
18	12	14	24	3½	4			
20	12	14	24	3½	4			
20	14	16	24	3½	4			

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

* When the water tank is provided with a float, pulley and cord, properly arranged so as to operate the throttle valve on the steam pipe, the Combined Injection and Refrigerator Pump is made to work AUTOMATICALLY. By this simple arrangement the supply of steam to the steam cylinder is regulated and the speed of the pump perfectly controlled. The injection water, as it is taken out of the supply tank by the condenser, immediately lowers the float, which in turn opens the steam throttle and speeds up the pump. On the rising of the float the pump decreases its speed, and when the tank is full the pump stops altogether.

Pumps for "INJECTION" or "REFRIGERATOR" service (not combined as above), see page 9, price-list of TANK OR LIGHT SERVICE PUMPS.

VACUUM PUMPS, see pages 64, 65, 66 67 and 70.

COMBINED VACUUM AND WATER PUMPS, see pages 68, 69, and 71.

KNOWLES PATENT

COMBINED "SWEET WATER" & SYRUP PUMPS.

For "Double Effects" and "Triple Effects," etc.

THE pumping plant of a plantation sugar house is considerably simplified by the use of Knowles Improved Combined "Sweet Water" and Syrup Pump. This machine combines efficiency and simplicity with economy in the use of steam.

The steam cylinder is placed between the "sweet water" pump and the syrup pump, to both of which it is directly connected—the general arrangement being similar to the engraving on page 68.

The "sweet water" pump is intended to drain the heating coils of the second and third vacuum pans of a "triple effect," or the coils of the second vacuum pan of a "double effect."

The syrup pump takes the boiling syrup from the last "effect" pan and pumps it to the "strike" pan.

SIZES AND PRICES:

Steam Cylinder. Inches.	SweetWater Cylinder. Inches.	Juice Cylinder. Inches.	Stroke. Inches.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Price.	REMARKS.
6	6	4	7	¾	1		
8	8	5	12	1	1¼		
10	10	6	12	1¼	1½		
12	12	7	12	2	2½		

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

Both pumps have gun-metal composition cylinder linings, valves, valve seats, pistons, piston rods and stuffing-boxes.

SUGAR-HOUSE PUMPS.

The Improved Knowles Pumps, as arranged for sugar-house work, whether for refinery or plantation, are, without exception, the most efficient and durable. They will pump cane-juice ("Gurapo"), syrup ("Meladura") and molasses, etc., with the greatest freedom, having pump valves especially designed for the purpose.

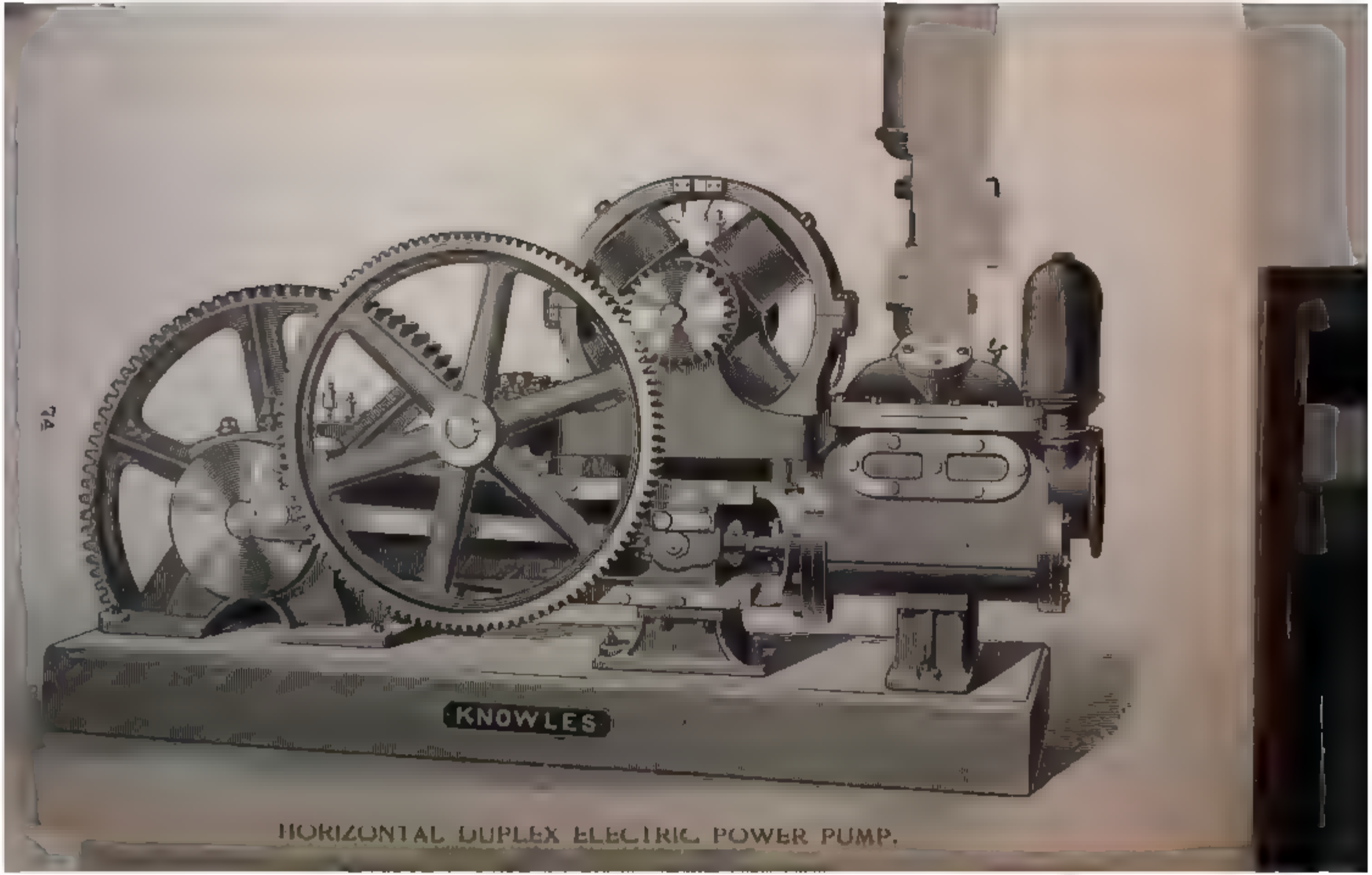
SIZES, CAPACITIES AND PRICES:

Steam Cylinder. Inches.	Pump Cylinder. Inches.	Stroke. Inches.	Gallons per Stroke.	Capacity per Minute at Ordinary Speed.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipe. Inches.	Delivery Pipe. Inches.	Price.
4	4	5	.27	125 Strokes, 33 gals.	½	¾	2	1½	
5	4	7	.39	125 " 49 "	¾	1	2½	2	
5½	5½	7	.72	125 " 90 "	¾	1	3	2½	
6	6	12	1.47	100 " 147 "	¾	1	4	4	
7½	7	10	1.66	100 " 166 "	1	1¼	4	4	
8	6	12	1.47	100 " 147 "	1	1¼	4	4	
8	7	12	2.00	100 " 200 "	1	1¼	5	5	
8	8	12	2.61	100 " 261 "	1	1¼	5	5	

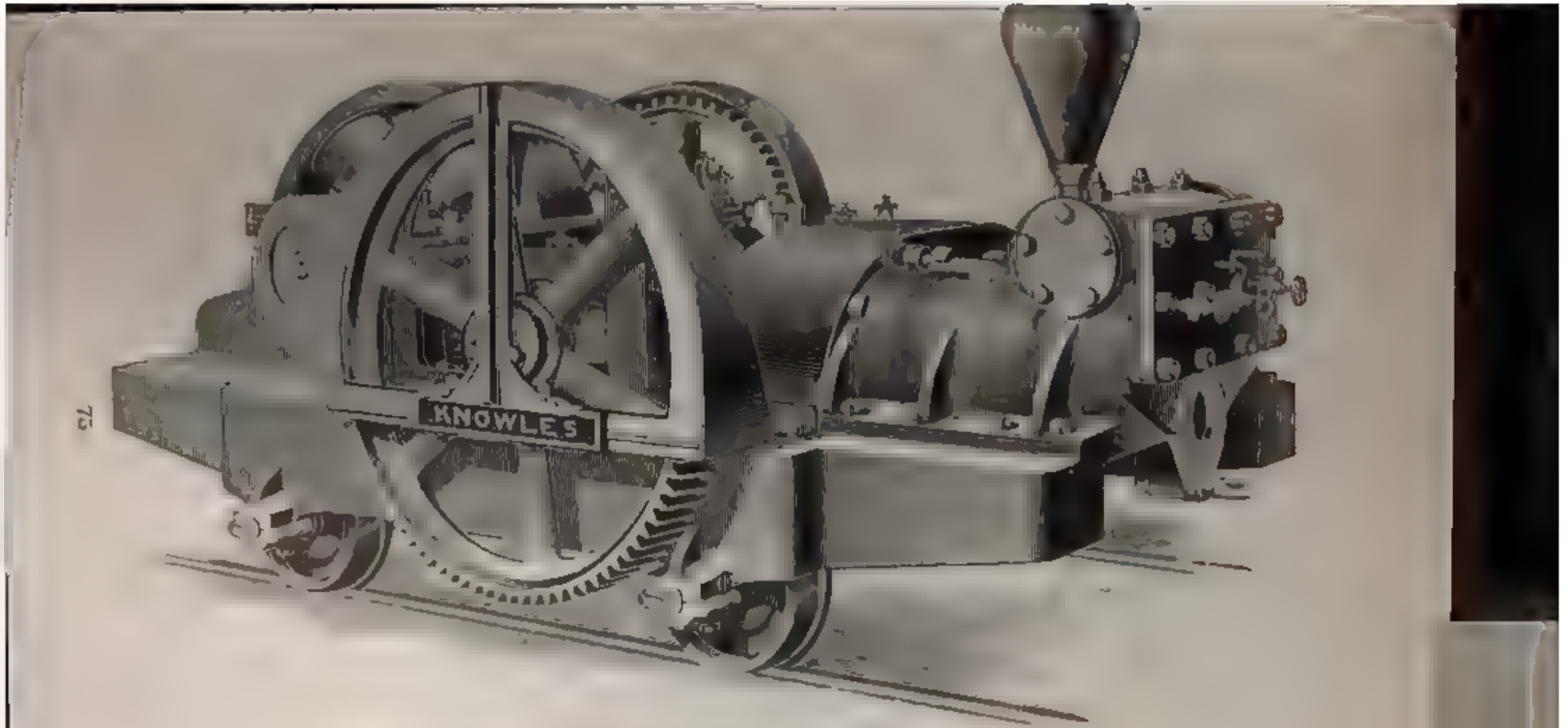
LARGER SIZES TO ORDER.

The linings, valves, valve seats, pistons, piston rods, stuffing-boxes, etc., of the pump cylinders are made of the best gun-metal composition.

When pumps are ordered to have pump cylinders made entirely of *gun-metal composition*, we use special light patterns for this purpose, charging only for the additional cost of composition metal.



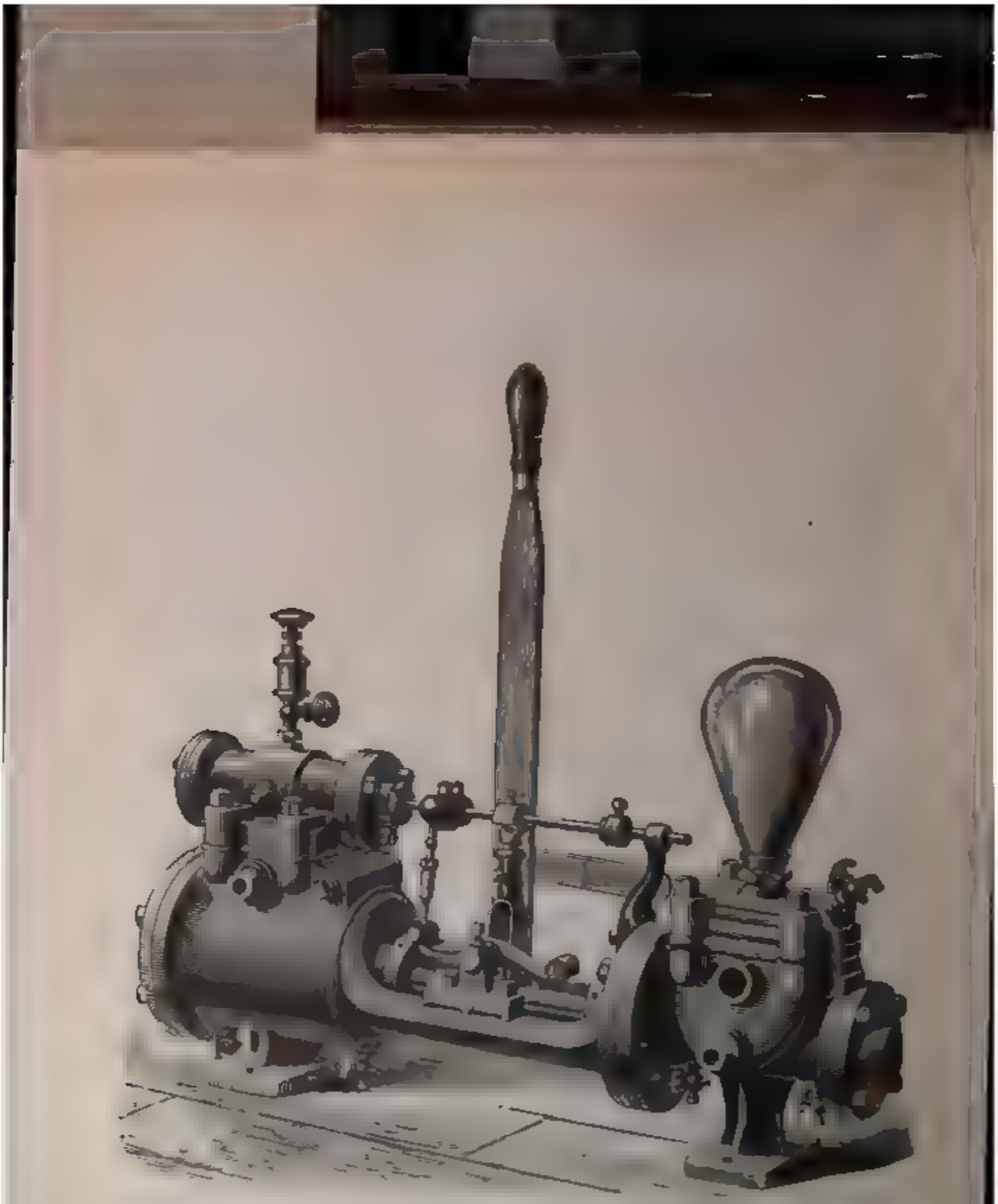
HORIZONTAL DUPLEX ELECTRIC POWER PUMP.



TRIPLEX PORTABLE ELECTRIC POWER MINE PUMP.

WITH SINGLE ACTING OUTSIDE PACKED PLUNGERS

Send for special catalogue of Electrically Operated Power Pumps



KNOWLES PATENT LOW-PRESSURE PUMP

With Hand Power Attachment

KNOWLES PATENT
LOW-PRESSURE PUMPS.

For Public and Private Buildings, etc.

THE Knowles Low-Pressure Pumps are constructed similar to our regular boiler-feed pumps—the only difference being that in the former the steam cylinders are much larger in proportion to the water cylinders, thereby enabling them to be operated by steam pressure ranging as low as three to ten pounds per square inch.

These pumps are principally used for elevating water in buildings where the low-pressure system of heating apparatus is in operation. They are perfectly *positive* in operation under any pressure—no matter how low. They work *without noise*, are easily managed and not liable to get out of order

SIZES, CAPACITIES AND PRICES.

Steam Cylinder Inches.	Water Cylinder Inches.	Stroke Inches.	Gallons per Stroke.	* Capacity per Minute at Ordinary Speed.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipe. Inches.	Discharge Pipe. Inches.	Price.
6	2	6	.08	125 Strokes, 11 gals.	¾	1	1¼	1	
7½	2½	7	.14	125 " 17½ "	1	1¼	1½	1¼	
8	3	7	.21	125 " 26 "	1	1¼		1¼	
10	3½	10	.40	125 " 50 "	1¼	1½	As desired.		
10	3½	12	.50	100 " 50 "	1¼	1½		As desired.	
12	4	12	.64	100 " 64 "	2	2¼			
12	4½	12	.82	100 " 82 "	2	2¼			
14	5	12	1.02	100 " 102 "	2½	3			

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS.

* Twice the above capacities can be had in emergencies, but for continuous work we advise about half the speeds stated.

Every pump has suction and delivery openings on both sides; consequently, connections can be made on either side desired. When ordering a pump, it is necessary to give height water is to be pumped, also the *maximum* quantity required per hour; also state steam pressure carried.

The PATENT HAND-POWER ATTACHMENT, as shown in engraving opposite, is furnished on the first three sizes. It is very convenient for hand pumping when steam is down.

☞ We also furnish these pumps arranged with Independent Low-Pressure Boilers, especially designed for domestic service. Prices, etc., on application.

VERTICAL FEED PUMPS.

For Locomotives, Steam Launches, etc.

FOR feeding boilers of locomotives, steam launches, steam yachts, and for other places where floor space is very limited, these Improved Vertical Pumps are especially adapted. They are double-acting, and, being very compact, take but little room. They are efficient, reliable and durable. Being *positive* and continuous in their action, they deliver a steady stream of water to the boilers at any speed desired

For locomotives they can be placed in any convenient position—under the foot boards, if preferred. For steam launches and steam yachts they are usually bolted to the *side* of the boilers.

SIZES, CAPACITIES AND PRICES

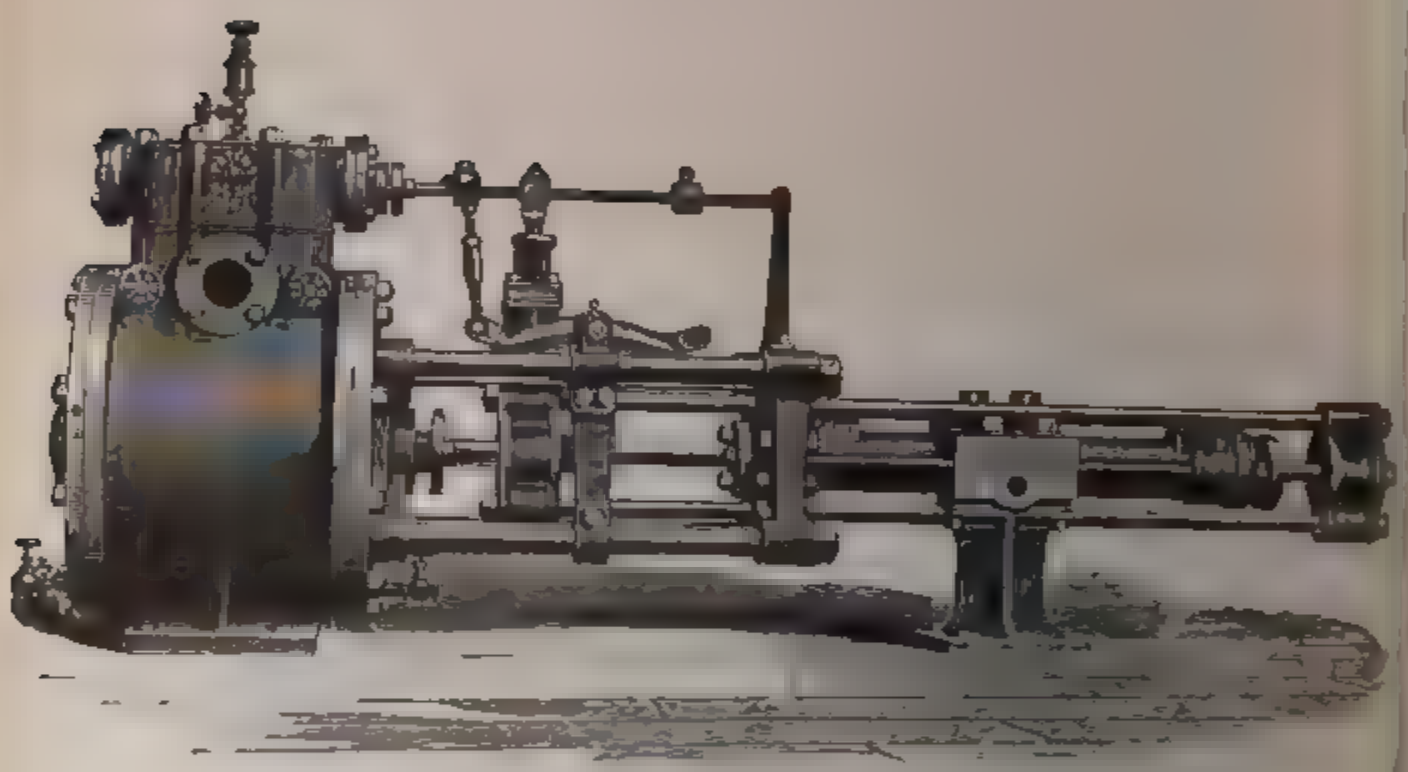
No.	Steam Cylinder Inches.	Water Cylinder. Inches.	Stroke. Inches.	Gallons per Stroke.	* Capacity per Minute at Ordinary Speed.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipe. Inches.	Delivery Pipe. Inches.	Price.
0	3¼	2	4	.05	6 Gallons.	½	¾	1¼	1	
1	3½	2¼	4	.07	10½ "	½	¾	1¼	1	
2	4	2¼	5	.15	16 "	½	¾	1¼	1	

LARGER SIZES TO ORDER.

* Twice the above capacities can be had in emergencies, but for continuous work, such as boiler-feeding, about half the capacities stated is fair work for regular duty

These pumps provided with our hand-power attachment without extra charge. By this PATENT ATTACHMENT the pump can be worked by hand, when steam is down, for filling boilers after "blowing off," washing decks, etc.

Patterns also for *vertical* TANK OR LIGHT SERVICE PUMPS, MARINE PUMPS, etc.

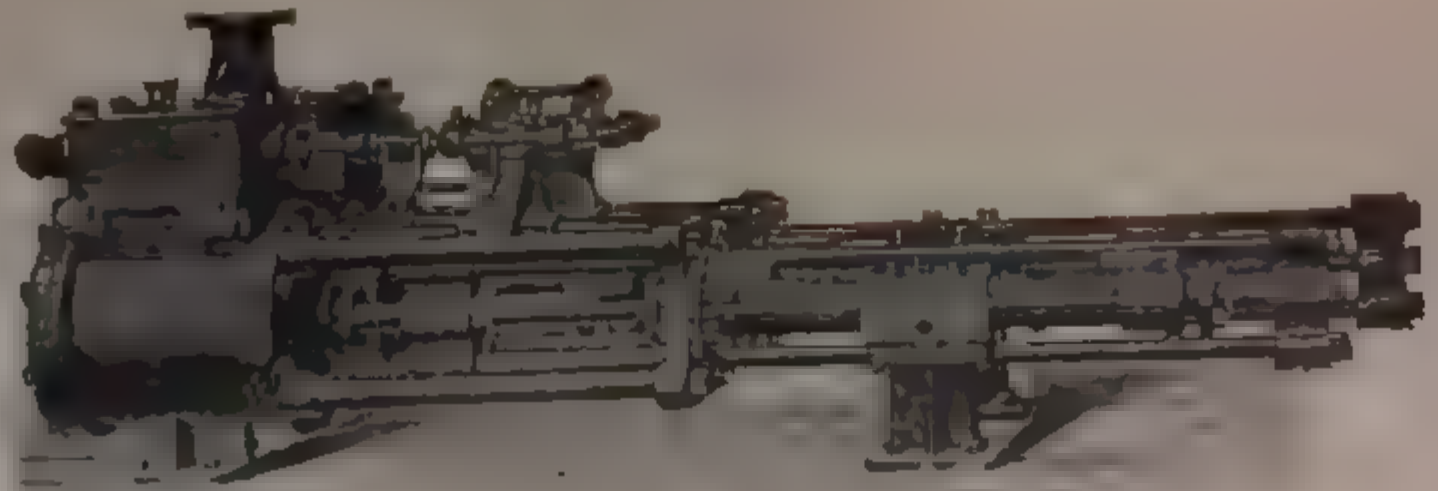


KNOWLES PATENT HYDRAULIC PRESSURE PUMP.

SINGLE CYLINDER PATTERN,

With Double-Acting Outside Connected Plungers

(See description and price list on pages 80 and 81.)



KNOWLES PATENT HYDRAULIC PRESSURE PUMP.

DUPLEX PATTERN,

With Double acting Outside Connected Plungers

(See description and price list on page 81.)

KNOWLES PATENT

HYDRAULIC PRESSURE PUMPS.

(AS ILLUSTRATED ON PAGE 79.)

For Steel Works, Hat Factories, Pipe Works, Paper Mills, Cotton and other Presses.

THE superior advantages of the Knowles Direct-acting Hydraulic Pressure Pumps for working hydraulic presses, etc., in lieu of crank pumps, with their complication of gears, fly-wheels, belts, pulleys, etc., has been fully demonstrated, especially among the owners of the large Southern cotton presses and oil mills. These improved pumps are also especially adapted for operating hydraulic cranes, testing machines, hydraulic riveting and punching machines, and hydraulic presses of all kinds. They are built from new and improved designs, combining great strength and power with simplicity and durability. We have patterns for every possible size or combination of steam cylinders to pump plungers, so that we can promptly fill orders for pumps to operate against any pressure desired—say from 200 to 12,000 lbs. per square inch.

These hydraulic pumps are *double-acting*, and will consequently deliver a steady, continuous flow of water. They are absolutely *positive* in operation, and can be run at the slowest speed possible. If desired, they can be operated automatically to run at varying speeds, according to the demands of the work to be performed.

On some of the largest hydraulic presses in this country we have these pumps in operation, where they are arranged in a series of two or more powers, and connected up to run *automatically*. The lowest power moves the ram of the press the greater distance against the minimum pressure, the next in the series moving the ram a less distance against the constantly increasing pressure, and so on, each in turn starting at the instant the preceding one attains its maximum pressure. By this arrangement a pumping plant of less *first* cost can be used and a saving of fuel secured.

SIZES AND PRICES:

Steam Cylinder. Inches.	Plungers. Inches.	Stroke. Inches.	Gallons per Stroke.	*Pressure Lbs.	Price.	Steam Cylinder. Inches.	Plungers. Inches.	Stroke. Inches.	Gallons per Stroke.	*Pressure Lbs.	Price.
4½	½ to 1	6				10	1	12	.04	5500	
5½	½	7	.006	7000		10	1⅛	12	.051	4700	
5½	¾	7	.013	3200		10	1¼	12	.063	3500	
5½	1	7	.024	1800		10	1½	12	.09	2500	
6	½	7	.006	8000		10	1¾	12	.12	1900	
6	¾	7	.013	3500		10	2	12	.16	1500	
6	1	7	.024	2000		10	2¼	12	.20	1200	
8	⅝	10	.013	9000		10	2½	12	.25	900	
8	¾	10	.020	6300		10	2¾	12	.31	700	
8	1	10	.034	3500		10	3	12	.37	600	
8	1⅛	10	.043	3000		12	1	12	.04	8600	
8	1¼	10	.053	2300		12	1¼	12	.063	5000	
8	1½	10	.076	1500		12	1½	12	.09	3000	
8	1¾	10	.10	1050		12	1¾	12	.12	2500	
8	2	10	.13	900		12	2	12	.16	2000	
8	⅝	12	.015	9000		12	2¼	12	.20	1500	
8	¾	12	.023	6800		12	2½	12	.25	1300	
8	1	12	.04	3500		12	2¾	12	.31	1100	
8	1⅛	12	.051	3000		12	3	12	.37	900	
8	1¼	12	.063	2300		14	1	12	.04	10000	
8	1½	12	.09	1500		14	1¼	12	.063	7000	
8	1¾	12	.12	1050		14	1½	12	.09	5000	
8	2	12	.16	900		14	1¾	12	.12	3500	
8	2¼	12	.20	700		14	2	12	.16	2700	
8	2½	12	.25	550		14	2¼	12	.20	2000	
10	¾	12	.023	8600		14	2½	12	.25	1700	

(CONTINUED ON NEXT PAGE.)

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KNOWLES PATENT

HYDRAULIC PRESSURE PUMPS—CONTINUED

Steam Cylinder. Inches.	Plungers. Inches.	Stroke. Inches.	Gallons per Stroke.	*Pressure Lbs.	Price.
14	2¾	12	.31	1550	
14	3	12	.37	1300	
16	1¼	12	.06	9800	
16	1½	12	.09	6800	
16	1¾	12	.12	5000	
16	2	12	.16	3800	
16	2¼	12	.20	3000	
16	2½	12	.25	2400	
16	2¾	12	.31	2000	
16	3	12	.37	1700	
16	1¼	18	.095	9800	
16	1½	18	.135	6800	
16	1¾	18	.18	5000	
16	2	18	.24	3800	
16	2¼	18	.30	3000	
16	2½	18	.37	2400	
16	2¾	18	.46	2000	
16	3	18	.55	1700	
16	3½	18	.68	1250	
16	4	18	.98	950	
16	2	24	.32	3800	
16	2¼	24	.40	3000	
16	2½	24	.50	2400	
16	2¾	24	.62	2000	
16	3	24	.74	1700	
16	3½	24	.90	1250	
16	4	24	1.30	950	
18	2	18	.24	4800	
18	2¼	18	.30	3800	
18	2½	18	.37	3100	
18	2¾	18	.46	2500	
18	3	18	.55	2100	
18	3½	18	.68	1500	
18	4	18	.98	1200	
18	2	24	.32	4800	
18	2¼	24	.40	3800	
18	2½	24	.50	3100	
18	2¾	24	.62	2500	
18	3	24	.74	2100	
18	3½	24	.90	1500	
18	4	24	1.30	1200	
20	2	18	.24	6000	
20	2¼	18	.30	4700	
20	2½	18	.37	3800	
20	2¾	18	.46	3100	
20	3	18	.55	2600	
20	3½	18	.68	1959	
20	4	18	.98	1500	
20	2	24	.32	6000	
20	2¼	24	.40	4700	
20	2½	24	.50	3800	
20	2¾	24	.62	3100	
20	3	24	.74	2600	
20	3½	24	.90	1900	
20	4	24	1.30	1500	
24	2	18	.24	8600	
24	2¼	18	.30	6800	
24	2½	18	.37	5500	
24	2¾	18	.46	4500	
24	3	18	.55	3800	
24	3½	18	.68	2800	
24	4	18	.98	2100	
24	4½	18	1.23	1700	
24	5	18	1.50	1300	
24	2	24	.32	8600	
24	2¼	24	.40	6800	
24	2½	24	.50	5500	
24	2¾	24	.62	4500	
24	3	24	.74	3800	
24	3½	24	.90	2800	
24	4	24	1.30	2100	
24	4½	24	1.65	1700	
24	5	24	2.00	1300	

ALSO PATTERNS FOR LARGER SIZES AND OTHER COMBINATIONS.

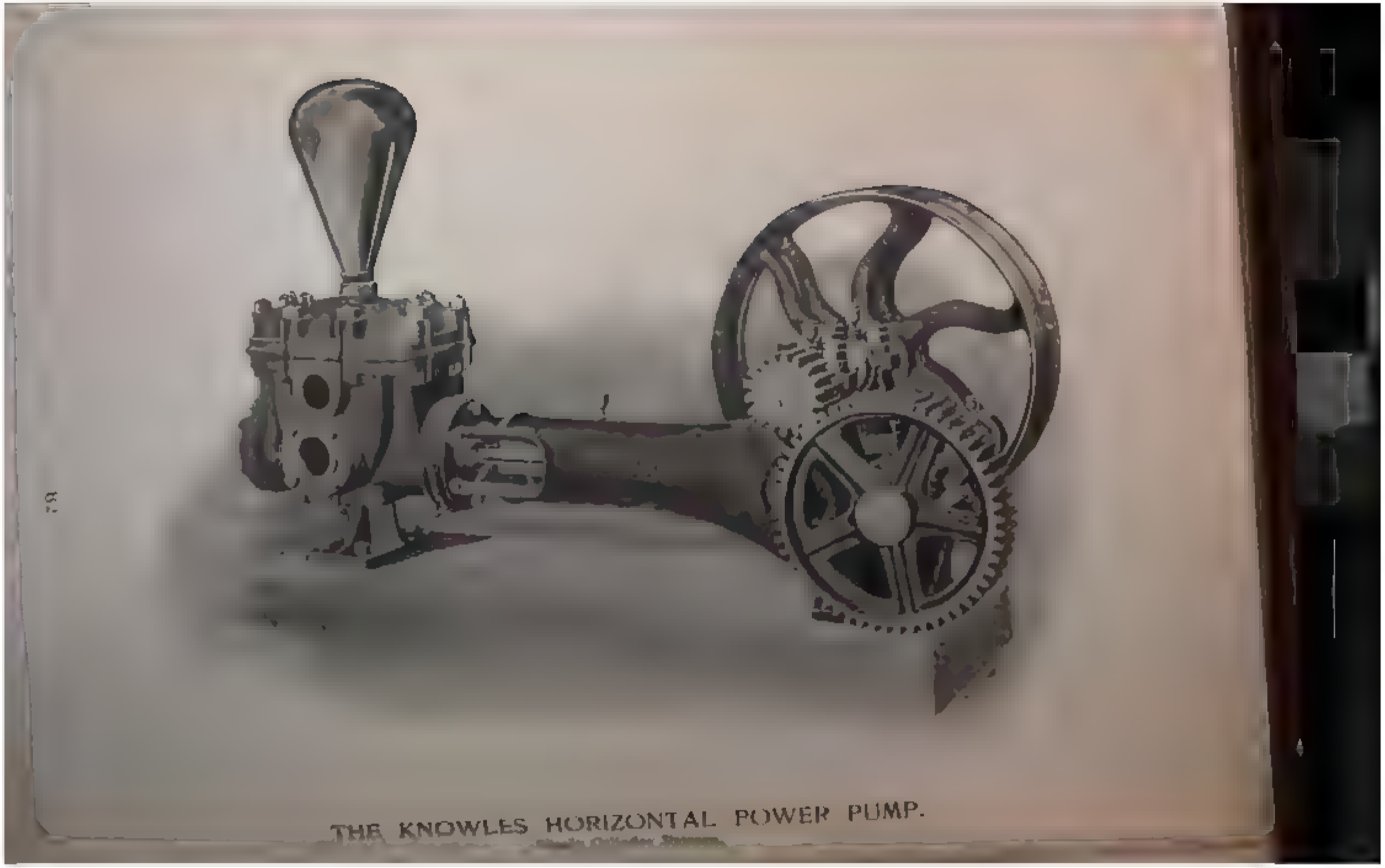
*The "pressure" columns give approximately the hydraulic pressure in pounds per square inch which can be exerted by the water plungers with a steam pressure of about 60 pounds in the Steam Cylinder, the pumps then standing balanced. Increasing the steam pressure will give proportionately greater hydraulic pressure.

AUTOMATIC PRESSURE REGULATORS, complete, with balanced steam throttles furnished when ordered at a slight additional cost.

CONNECTIONS.—Suction and discharge connections arranged according to requirements of each case. The steam and exhaust connections are the same as given for steam cylinders of pumps in table on page 5.

DUPLEX HYDRAULIC PRESSURE PUMPS.

AS shown by illustration on page 79, we also make our improved Hydraulic Pressure Pumps on the *duplex* plan. They are very steady in action, and can be operated automatically, same as the above. We have new and improved designs and patterns for all sizes. Prices and further particulars on application.



THE KNOWLES HORIZONTAL POWER PUMP.

THE KNOWLES

HORIZONTAL POWER PUMP.

Single Cylinder Pattern.

THE cut on opposite page shows one of our improved power pumps, Double Acting Single Cylinder pattern, fitted with gears. We also make the same pump designed to drive directly by belt, without intermediate gearing. This style of pump has suction and discharge valves above the cylinder barrel, and is designed to stand a water pressure of 100 pounds per square inch. Adjustments are provided, so that wear can be taken up in all bearings, slides, and other parts subject to wear. Every part is carefully proportioned, and material and workmanship are of the best. All gears and pinions have machine cut teeth.

The best gun metal composition is used in the linings, stuffing boxes, valve seats, and pistons, the latter being suitably packed for hot or cold water or other liquids.

Heavy balance wheels are provided for all sizes.

The capacities in the table below are figured at the moderate speed of 80 feet piston travel per minute, this can be increased if desired.

We have patterns also for power pumps arranged with *inside or outside plungers*, suitable for gritty or bad water

When sending inquiries or orders, always state the pressure against which pump will have to work.

SIZES AND CAPACITIES.

Diameter of Piston	Stroke	Gallons per Revolution	Gallons per Minute	Suction	Discharge	Code Word.	Diameter of Piston.	Stroke	Gallons per Revolution	Gallons per Minute	Suction	Discharge	Code Word
3	6	.36	29	2	1½	Elusion	9	12	6.00	264	6	6	Embalmer
3¼	6	.43	35	2	1½	Elusive	10	12	8.14	326	6	6	Embank
3¾	6	.57	46	2	1½	Elusory	10	16	10.86	326	6	6	Embargo
4	6	.66	52	2½	2	Eluted	10	24	16.32	326	6	6	Embase
3¼	10	.72	35	2½	2	Eluting	12	12	11.74	470	8	6	Embattle
3¾	10	.96	46	2½	2	Eluxate	12	16	15.66	470	8	6	Embay
4⅜	10	1.11	54	3	2½	Elvan	12	24	23.48	470	8	6	Ember
4½	10	1.38	65	3	2½	Elvish	14	16	21.32	640	10	8	Embezzle
5	10	1.70	82	3	2½	Elysian	14	24	32.00	640	10	8	Emblaze
6	12	2.93	117	4	4	Emaciate	16	16	27.84	836	2	10	Emblem
7	12	4.00	160	5	5	Emanate	16	24	41.76	836	2	10	Embody
8	12	5.22	209	5	5	Embale							

ALSO PATTERNS FOR LARGER SIZES OR COMBINATIONS.

KNOWLES PATENT POWER PUMP.

DUPLEX PATTERN.

THE KNOWLES HORIZONTAL

DUPLEX POWER PUMP.

PISTON, OR INSIDE PLUNGER PATTERN. GIRDER 97 FRAME.

THE Duplex form of Power Pumps we recommend for water works service, for supplying hydraulic elevators and for such other places as require a very steady or heavy pressure with uniform action. These pumps can be geared directly to the jack shaft of turbine water wheels, or can be driven by belt or gear connection from line shafting run by water or steam power. For hydraulic elevator work they are often driven by gas engines.

These pumps are carefully designed and built with great thoroughness. Each water cylinder is double-acting, and is arranged with lining and valve-seats of composition. The crank-shafts, connecting rods, cross-heads, gears, etc., are well proportioned and made of the very best materials. All bearings, slides, etc., are arranged for taking up wear. The cranks are set at right angles; as shown by the engraving on opposite page, these pumps are arranged with heavy band wheels.

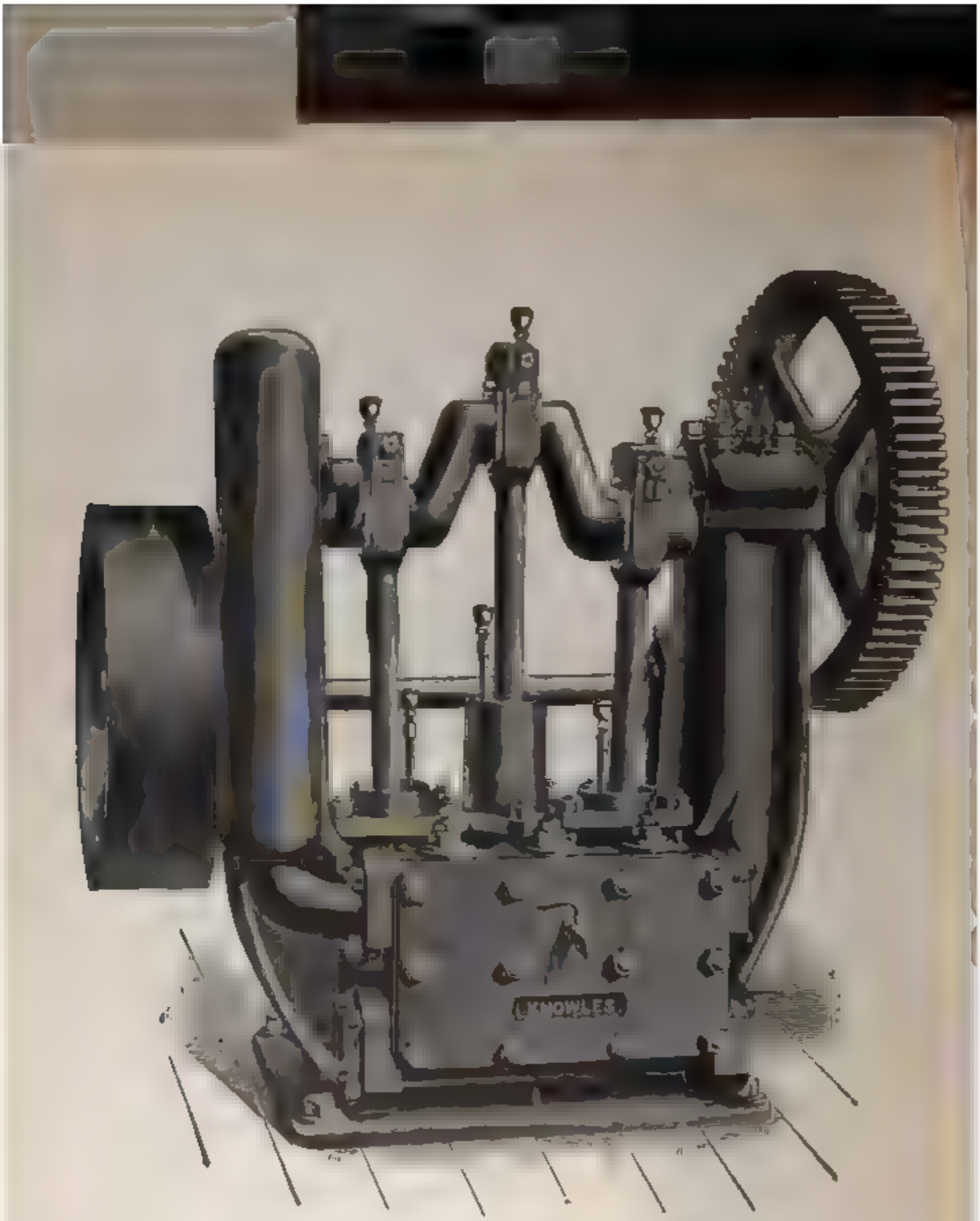
All gears have machine-cut teeth. All sizes in the following list can be made for water pressures as high as 130 pounds per square inch. We have also many patterns for pumps of this type designed for lighter, and for heavier pressures than the above. As the cost of a power pump depends largely upon the pressure it must be suited for, always in sending inquiries or orders state the water pressure pump must develop, as well as the capacity required.

SIZES AND CAPACITIES

Diameter of Cylinders	Stroke	Gallons per Revolution (Both Cylinders)	Gallons per Minute.	Suction	Discharge	Code Word	
						Piston Pattern	Inside Plunger Pattern
3¾	6	1.14	92	3	2	Emphasis	Emulous
4⅛	6	1.39	111	3	2	Emphatic	Emulsion
5½	6	2.47	198	5	4	Empight	Emulsive
5	12	4.08	163	5	4	Empiric	Enable
6	12	5.88	235	5	4	Emporium	Enabling
7	12	8.00	320	6	5	Empower	Enact
8	12	10.44	418	8	6	Empress	Enacting
9	12	13.20	528	10	8	Emprise	Enactive
10	12	16.28	651	10	8	Emption	Enactor
10	18	24.42	651	12	10	Empurple	Enambush
12	12	23.48	940	12	10	Empuse	Enamor
12	18	35.20	940	12	10	Empyema	Enarmed
12	24	46.97	940	14	12	Empyreal	Enate
14	18	48.00	1280	14	12	Emulate	Enaunter
14	24	64.00	1280	14	12	Emule	Encamp
16	18	62.66	1670	16	14	Emulge	Encamped
16	24	83.55	1670	16	14	Emulgent	Encanker

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS

The capacities are figured at moderate speed, namely, 80 feet piston travel per minute. This speed can be increased if desired.



VERTICAL TRIPLEX BELTED POWER PUMP.

Size 4x6 Style B

We issue a special catalogue on triplex power pumps, both belt driven and electric driven, which we will send on application

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KNOWLES VERTICAL TRIPLEX

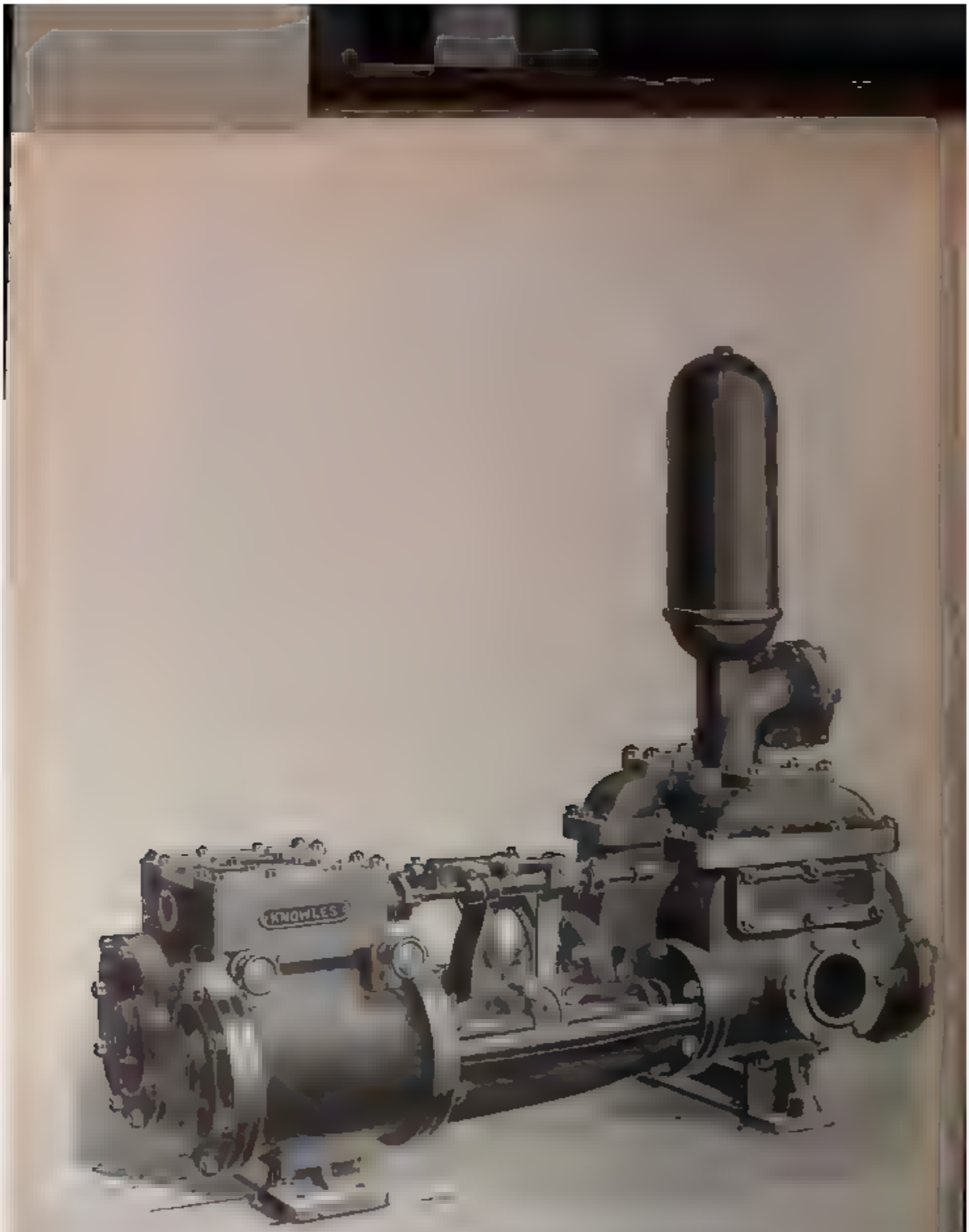
BELTED POWER PUMP.

SIZES, CAPACITIES, AND DIMENSIONS.—FOR 300 FEET LIFT.

Diameter of Plungers.	Stroke.	Revolutions per Minute.	Gallons per Revolution.	Gallons per Minute.	Suction.	Discharge.	Style	Pulleys, Tight and Loose. Diameter	Pulleys, Tight and Loose. Face	Ratio of Gears	Dimensions over all. Length.	Dimensions over all. Width.	Dimensions over all. Height.	Code Word.
1¼	2	60	.0319	1 9	¾	¾	D	12	1¾	5 to 1	16⅞	10 13/16	18¼	Dabble
1¾	2½	60	.0780	4 6	1	1	D	12	1¾	5 " 1	19	14½	22½	Dabster
2	3	50	.1224	6 1	1¼	1¼	D	12	2½	5 " 1	23 1/16	16	27	Dado
2¼	3	50	.1912	9 5	1½	1½	D	12	2¼	5 " 1	25¼	17¼	28	Daffodil
2½	4	50	.2500	12 5	1½	1½	B	15	3	5 " 1	27	17	31	Dagger
3	4	45	.3673	16.5	1½	1½	B	15	3	5 " 1	32¼	23	29	Dainty
4	4	45	.6528	29.3	2	2	B	20	3	5 " 1	38¼	28¼	39¼	Dairy
4	6	40	.9787	39 1	2	2	B	20	3	5 " 1	38¼	28¼	39¼	Dahlia
5	6	40	1.530	61 2	3	3	B	26	4	5 " 1	46½	35	48½	Dally
5	8	40	2.040	81 6	3	3	B	30	5	5 " 1	48½	37	48½	Damask
6½	8	40	3.448	137	4	4	B	30	6	5 " 1	62¾	42½	59	Damper
8	8	40	5.222	208	5	4	B	36	6	5 " 1	71	52	62	Damsel
8	10	40	6.525	261	5	4	B	42	6	5 " 1	71	55	63½	Dander
8	12	40	7.833	314	5	4	A	42	6	6 " 1	88	81	105	Dapper
9	10	40	8.262	330	5	4	A	42	6	6 " 1	88	81	105	Darkly
9	12	40	9.915	397	6	5	A	4	8	6 " 1	88	81	105	Darling
10	12	40	12.243	490	8	7	A	42	8	6 " 1	93⅞	81	106½	Dastard
								¼ Pulley						
11	12	40	14.811	592	8	7	A	42	10	6 " 1	93⅞	81	106½	Dauber
12	12	40	17.628	705	8	8	A	48	10	6 " 1	97½	88	109½	Daunted
13	12	40	20.685	827	10	8	A	48	12	6 " 1	97½	88	109½	Dazzle

SIZES, CAPACITIES, AND DIMENSIONS.—FOR 100 FEET LIFT.

Diameter of Plungers	Stroke	Revolutions per Minute	Gallons per Revolution	Gallons per Minute	Suction	Discharge	Style	Pulleys, Tight and Loose. Diameter	Pulleys, Tight and Loose. Face	Ratio of Gears	Dimensions over all. Length.	Dimensions over all. Width.	Dimensions over all. Height.	Code Word.
4	4	45	.6528	29	2	2	E	20	3	5 to 1	32½	32½	34	Factive
4	6	40	.9787	39	2	2	E	20	3	4 " 1	32½	32½	34	Factorage
5	6	40	1 530	61	3	3	E	20	4	4 " 1	40¼	38	44	Factotum
6	8	40	2 040	81	3	3	E	20	4	4 " 1	40¼	38	44	Factual
6½	8	40	3 448	137	4	4	E	26	5	4 " 1	54	43	55	Facture
7	8	40	3.998	159	5	4	E	30	5	4¼ to 1	54	43	55	Faculty
8	8	40	5.222	208	5	4	E	30	6	5 to 1	59	43	57½	Facund
8	10	40	6.525	261	5	4	E	36	6	5 " 1	59	43	57½	Faddle
8	12	40	7.833	314	5	4	E	36	6	5 " 1	67	48	69	Fadeless
9	10	40	8 262	330	5	4	F	30	5	5 " 1	82	59½	82	Fairly
9	12	40	9.915	397	6	5	F	30	5	5 " 1	87	66	90	Fairness
10	12	40	12.243	490	8	7	F	30	6	5 " 1	87	66	95	Fairy
11	12	40	14.811	592	8	7	F	30	6	4.85 to 1	87	66	95	Fairylike
12	12	40	17.628	705	10	8	F	42	8	5 to 1	96½	78	101	Faith
13	12	40	20.685	827	10	8	F	42	8	5 " 1	96½	78	101	Faithful



KNOWLES IMPROVED DUPLEX PUMP.

REGULAR PISTON PATTERN

KNOWLES IMPROVED

DUPLEX STEAM PUMPS.

REGULAR PISTON PATTERN FOR FEEDING BOILERS, ETC.

TO meet a preference occasionally expressed for a well-made inexpensive duplex pump, to work against moderate pressure, with clear water, such as operating hydraulic elevators, pumping into the tanks of buildings, feeding boilers, etc , we have built a complete set of patterns embodying many decided improvements upon the duplex pumps commonly found in the market.

In the Knowles Improved Duplex Pumps plain slide valves are used of the most durable form, worked by a very simple and adjustable valve motion of improved design. The water pistons and valves are adapted to the liquid to be pumped. **The water cylinders are brass lined.**

The weight of these pumps is from *ten* to *twenty* per cent greater than the duplex pumps of other makers, as commonly built; they also have the advantage of *longer stroke*, and as the wear of the pump depends on the number of *reversals* of motion made in a given time, their durability is proportionately increased by this feature. Another great advantage in the longer stroke is the smaller amount of steam necessary, on account of less clearance, for a given amount of piston speed.

SIZES, CAPACITIES AND PRICES:

Steam Cylinders. Inches.	Water Cylinders. Inches.	Stroke. Inches.	Gallons per Stroke each Piston	Strokes per Minute of each Piston Ordinary Speed.	Capacity of both Cylinders at Speed stated (per Minute). Gallons.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipe. Inches.	Delivery Pipe. Inches.	Floor Space required. Inches.	Price
3	2	3	.046	75 to 200	9 to 18	⅜	½	1¼	1	36 x 12	
4½	2¾	4	.10	75 to 150	15 to 30	½	¾	2	1½	38 x 13	
5¼	3½	6	.24	75 to 150	36 to 72	¾	1¼	2½	2	52 x 20	
6	4	7	.39	75 to 125	58 to 97	1	1½	3	2½	54 x 24	
7½	4½	10	.69	60 to 120	82 to 164	1½	1½	4	3	60 x 24	
8	5	12	1.02	50 to 100	102 to 204	1½	1½	5	4	80 x 31	
8	6	12	1.47	50 to 100	147 to 294	1½	1½	5	4	80 x 31	
10	6	12	1.47	50 to 100	147 to 294	2	2½	5	4	80 x 31	
12	7	12	2.00	50 to 100	200 to 400	2	2½	6	5	83 x 35	
12	8½	12	3.00	50 to 100	300 to 600	2	2½	6	5	83 x 37	
14	8½	12	3.00	50 to 100	300 to 600	2½	3	6	5	83 x 37	
14	10½	12	4.50	50 to 100	450 to 900	2½	3	8	7	83 x 44	
16	10½	12	4.50	50 to 100	450 to 900	3	3	8	7	83 x 44	
16	12	12	5.87	50 to 100	587 to 1174	3	3	10	8	83 x 50	
18½	10½	12	4.50	50 to 100	450 to 900	3	3	8	7	83 x 44	
18½	12	12	5.87	50 to 100	587 to 1174	3	3	10	8	83 x 50	
18½	14	12	8.00	50 to 100	800 to 1600	3	3	12	10	83 x 57	
20	14	18	12.00	40 to 70	960 to 1680	4	6				

PUMPS FITTED WITH COMPOSITION PISTON RODS, ETC., AT A SLIGHT ADDITIONAL COST.

*Duplex pumps, arranged with inside plungers instead of the regular piston pattern will be furnished at the same prices when ordered.

Light service or Tank Duplex pumps, **see pages 95 A and 95 B**

KNOWLES SPECIAL DUPLEX PUMP

Size, 6x4x6.

[redacted]

The Knowles Special Duplex Pump.

Pressure Pattern, for Boiler Feeding, Etc.

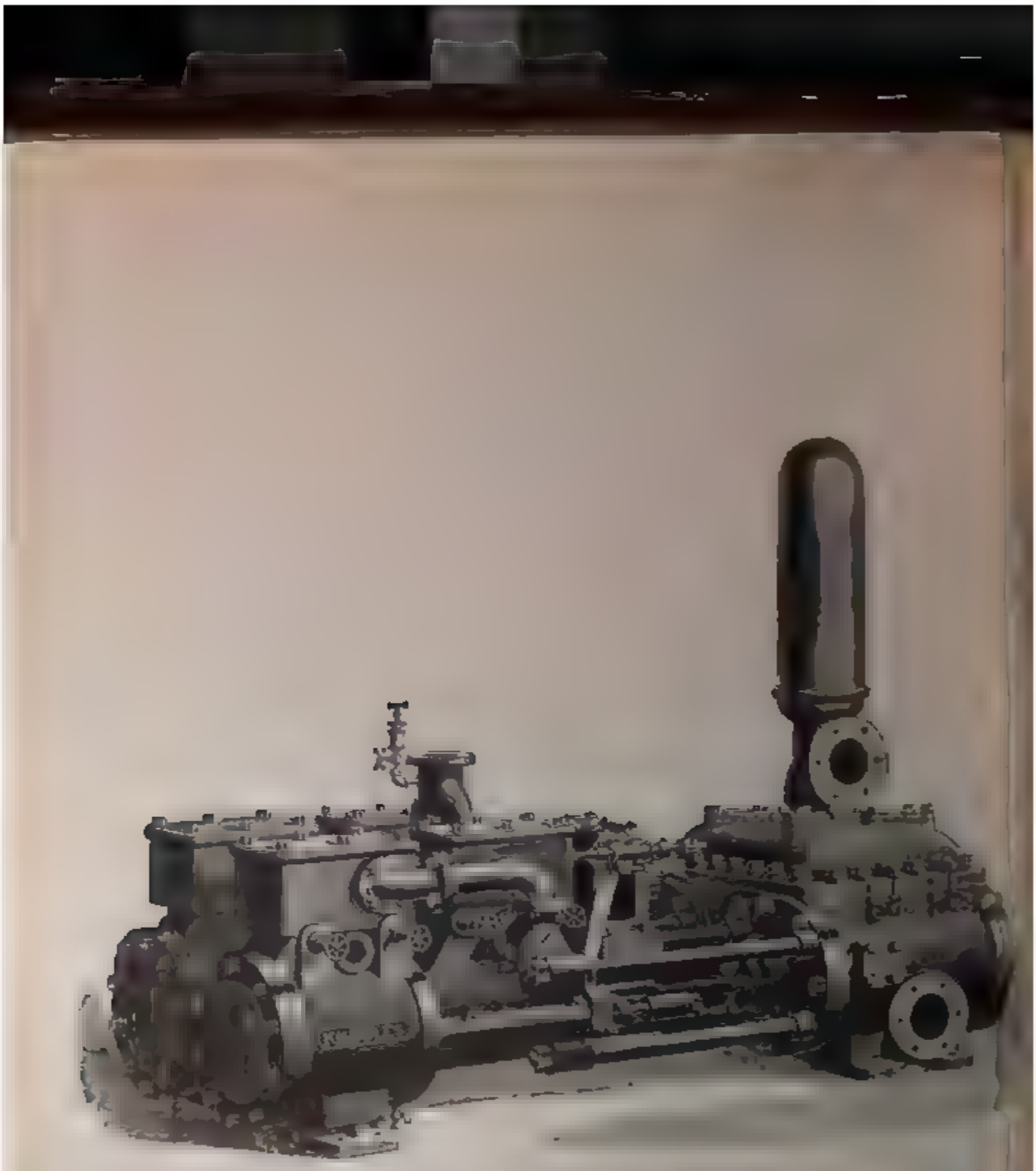
:ut on opposite page shows one of our special pattern duplex pumps (size, 6 x 4 x 6). ese pumps are provided with double acting water pistons, and are suitable for eding, fire service, or for general purposes. The water cylinders are brass d the water pistons are arranged so that the packing may be readily renewed quired.

Stroke	Capacity in Gallons per Stroke each Piston.	Strokes per Minute, each Piston.	Capacity of Both Cylinders, in Gallons, per Minute.	Steam Pipe.	Exhaust Pipe	Suction Pipe	Discharge Pipe.	Telegraphic Code Word	
Ins.				Ins.	Ins	Ins	Ins.	Regular	Brass Fitted.
2¾	.014	100 to 300	2 to 8	⅜	½	1	¾	Gabble	Gallisme
3	.04	100 " 250	8 " 20	⅜	½	1¼	1	Gablet	Gallitos
4	.10	100 " 200	20 " 40	½	¾	2	2	Gadding	Gallivats
5	.20	100 " 200	40 " 80	¾	1¼	2½	2½	Gaffer	Gallivespa
6	.33	100 " 150	66 " 100	1	1½	3	3	Gaffle	Galliwasp
6	.42	100 " 150	85 " 125	1¼	1½	4	3	Gaggling	Galliziano
6	.51	100 " 150	100 " 150	1¼	1½	4	3	Gaiety	Gallizzi
10	.69	75 " 125	100 " 170	1¼	1½	4	3	Gaily	Gallloch
10	.93	75 " 125	135 " 230	1½	2	4	3	Gainable	Gallofeeis
10	1.22	75 " 125	180 " 300	1½	2	5	4	Gainful	Gallois
10	1.66	75 " 125	245 " 410	1½	2	6	5	Gainless	Gallomane
10	1.66	75 " 125	245 " 410	2½	3	6	5	Gainsay	Gallonammo
10	1.66	75 " 125	245 " 410	2½	3	6	5	Gainstand	Gallonassi
10	2.45	75 " 125	365 " 610	2½	3	6	[illegible]	Gairish	Gallonato
10	2.45	75 " 125	365 " 610	2½	3	6	5	Gaiter	Gallonerai
10	2.45	75 " 125	365 " 610	2½	3	6	5	Galaxy	Galloon
10	2.45	75 " 125	365 " 610	3	3½	6	5	Galbulus	Gallooned
10	3.57	75 " 125	530 " 890	2½	3	8	7	Galiot	Gallopade
10	3.57	75 " 125	530 " 890	2½	3	8	7	Gallant	Gallophobe
10	3.75	75 " 125	560 " 935	2½	3	8	7	Gallate	Galloping
10	3.75	75 " 125	560 " 935	3	3½	8	7	Galleass	Gallorum
10	3.75	75 " 125	560 " 935	4	5	8	7	Gallego	Gallowglas
10	4.89	75 " 125	730 " 1220	2½	3	10	8	Galleon	Gallows
10	4.89	75 " 125	730 " 1220	3	3½	10	8	Gallery	Gallreich
10	4.89	75 " 125	730 " 1220	4	5	10	8	Galliambic	Galluche
10	6.66	75 " 125	990 " 1660	2½	3	12	10	Gallian	Gallula
10	6.66	75 " 125	990 " 1660	3	3½	12	10	Galliard	Gallulasco
10	6.66	75 " 125	990 " 1660	4	5	12	10	Gallic	Gallulorum
12	10.44	50 " 100	1000 " 2000	3	3½	14	12	Gallican	Gallulos
12	10.44	50 " 100	1000 " 2000	4	5	14	12	Gallicism	Gallulum

ALSO PATTERNS FOR LARGER SIZES.

slight additional charge is made when pumps are fitted with brass pistons and ston rods.

designate the sizes *give the diameter of steam* and water cylinders and length of r use *code word.*



KNOWLES IMPROVED COMPOUND DUPLEX PUMP.

Non-Condensing

*** The engraving above shows our regular inside plunger pattern. We furnish these pumps also with regular piston water cylinders at the same price.

[redacted]

KNOWLES IMPROVED

COMPOUND DUPLEX STEAM PUMPS.

(NON-CONDENSING.)

Regular Inside Plunger Pattern.

THE compound arrangement of steam cylinders for our Improved Duplex Pumps is for the purpose of using steam expansively—the same as in a regular cut-off steam engine—thereby saving about one-third of the steam necessary for a plain duplex pump, and consequently requiring less boiler capacity.

The steam, after use in the high pressure steam cylinders, is expanded into the low pressure steam cylinders, without complication of working parts, or expensive valve gear.

Proprietors of large buildings, managers of public institutions, and officers of town and village water works, will fully appreciate the advantages gained by the use of the compound system, as the saving in fuel will more than justify the additional first cost over the ordinary duplex pumps.

The engraving opposite shows our Compound Duplex Pump, with regular inside plunger pattern water end We also furnish these Compound Pumps with regular piston pattern water cylinders like the water end of duplex pump shown on page 86, at same price.

SIZES, CAPACITIES AND PRICES:

High Pressure Steam Cylinders. Inches.	Low Pressure Steam Cylinders. Inches.	Water Plungers. Inches.	Stroke. Inches.	Gallons per Stroke of each Plunger.	Strokes per Minute of each Plunger.	Capacity of both Plungers at Speed stated (per Minute). Gallons.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipe Inches.	Delivery Pipe. Inches.	Price.
8	and 12	6	12	1.47	50 to 100	147 to 294	2	2½	5	4	
8	and 12	7	12	2.00	50 to 100	200 to 400	2	2½	6	5	
8	and 12	8¾	12	3.00	50 to 100	300 to 600	2	2½	6	5	
8	and 12	10⅜	12	4.50	50 to 100	450 to 900	2	2½	8	7	
8	and 12	12	12	5.87	50 to 100	587 to 1174	2	2½	10	8	
10	and 16	8¼	12	3.00	50 to 100	300 to 600	2	4	6	5	
10	and 16	10½	12	4.50	50 to 100	450 to 900	2	4	8	7	
10	and 16	12	12	5.87	50 to 100	587 to 1174	2	4	10	8	
12	and 18	10⅜	12	4.50	50 to 100	450 to 900	2	4	8	7	
12	and 18	10⅜	18	6.75	35 to 70	540 to 900	2	4			
12	and 18	12	12	5.87	50 to 100	587 to 1174	2	4			
12	and 18	12	18	8.80	40 to 70	704 to 1174	2	4			
12	and 18	14	12	8.00	50 to 100	800 to 1600	2	4			
12	and 18	14	18	12.00	40 to 70	960 to 1680	2	4			
14	and 20	10⅜	18	6.75	40 to 70	540 to 900	3	6			
14	and 20	12	18	8.80	40 to 70	704 to 1174	3	6			
14	and 20	14	18	12.00	40 to 70	960 to 1680	3	6			

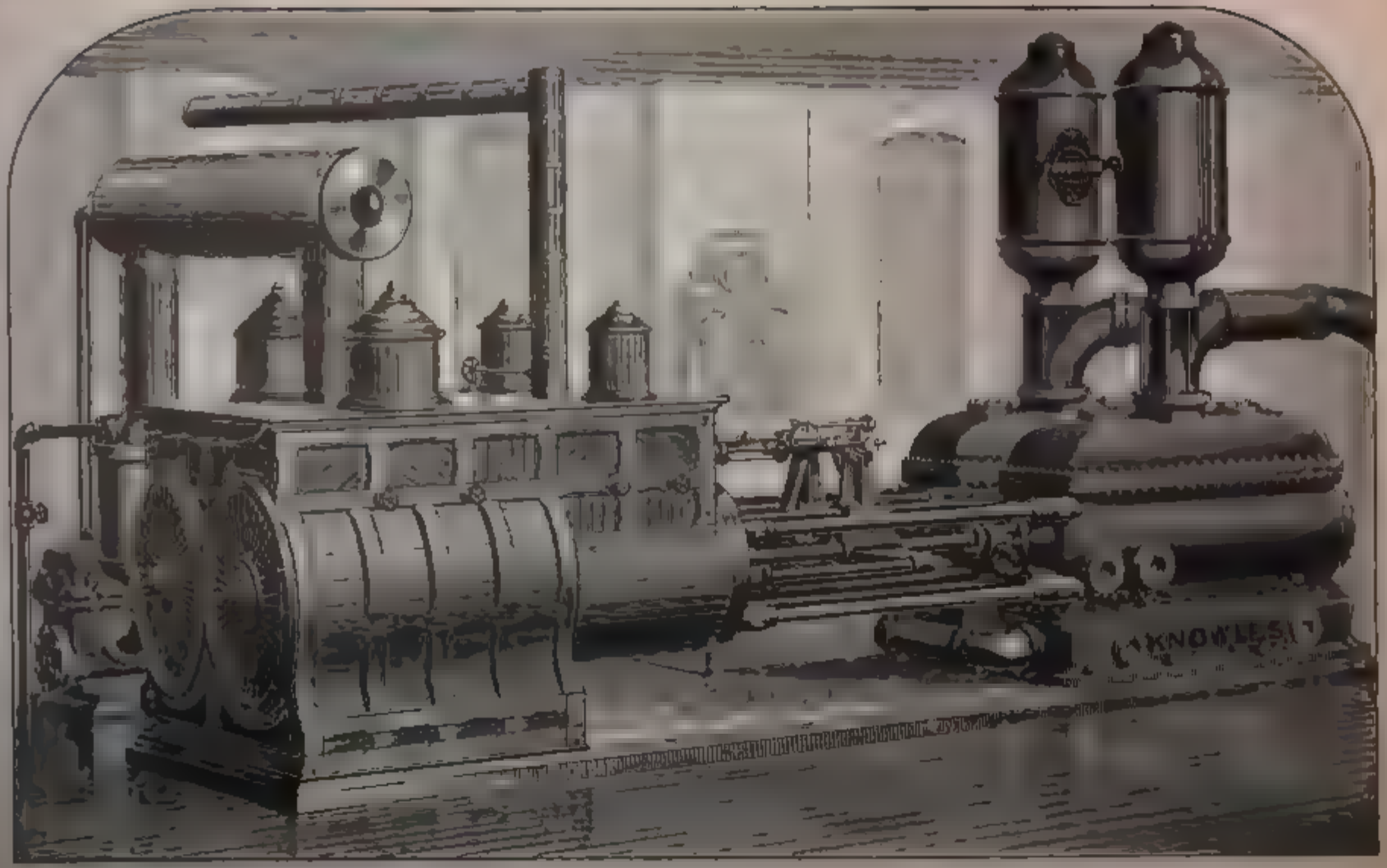
PUMPS FITTED WITH COMPOSITION PLUNGERS AND PISTON RODS, PER CENT EXTRA

The steam cylinders of above pumps are proportioned to use steam at a pressure of not less than 40 lbs., and not exceeding 60 lbs., in order to secure the best economic results.

When it is desired to increase the water pressure, as in case of fire, etc., a branch pipe from the regular steam connection should be made to the low pressure cylinders, when pump is piped up. The valve on this connection can be opened sufficiently to give the amount of direct steam from boiler that may be necessary to secure the water pressure desired.

*** The application of our Independent Air Pump and Condenser (particulars of which are given on pages 54 and 55) to the larger sizes of above pumps, serves to increase their economy to a still higher degree, and also does away with the noise and nuisance of steam exhausting into the atmosphere.

COMPOUND CONDENSING DUPLEX PUMPING ENGINES FOR WATER WORKS, etc., see next three pages.



KNOWLES IMPROVED COMPOUND CONDENSING DUPLEX PUMPING ENGINE.

With Independent Air Pump and Condenser.

KNOWLES IMPROVED

COMPOUND CONDENSING PUMPING ENGINES.

DIRECT-ACTING DUPLEX PATTERN.

For Water Works Service of Cities, Towns and Villages, Iron and Steel Works, etc.

THE Direct-Acting Compound Condensing Pumping Engines of Knowles Improved Duplex type are, without exception, the most desirable pumping engines that can be adopted for use in water works pumping stations, and other places where strict *economy* in the consumption of fuel is considered. These pumping engines are built from new designs combining the latest improvements, and we can confidently say that they are models of superior workmanship, economy and efficiency.

They are considerably less expensive in first cost, and require less attention and repairs, than any form of rotative or "Cornish" pumping engines in use. No costly engine houses or massive foundations are necessary; while the economical advantages resulting from the expansion and condensation of steam are very effectively obtained without the complication of parts, such as cranks, fly-wheels, eccentrics, journals, connecting-rods, slides, working-beams, etc., which are always liable to derangement and subject to lost motion and eccessive friction, to say nothing of the expense for the increased attendance, lubricants, etc.

In these Improved Pumping Engines there are but two sets of working parts—*i.e.*, the main piston-rods with their steam pistons and water-plungers, and the steam valves with their valve rods and valve gear.

Having a full set of patterns for all sizes—from one million to fifteen million gallons capacity per diem—and superior manufacturing facilities, we are prepared to construct and erect at short notice the most complete pumping works. We desire to call the attention of water boards and committees to the fact that we have

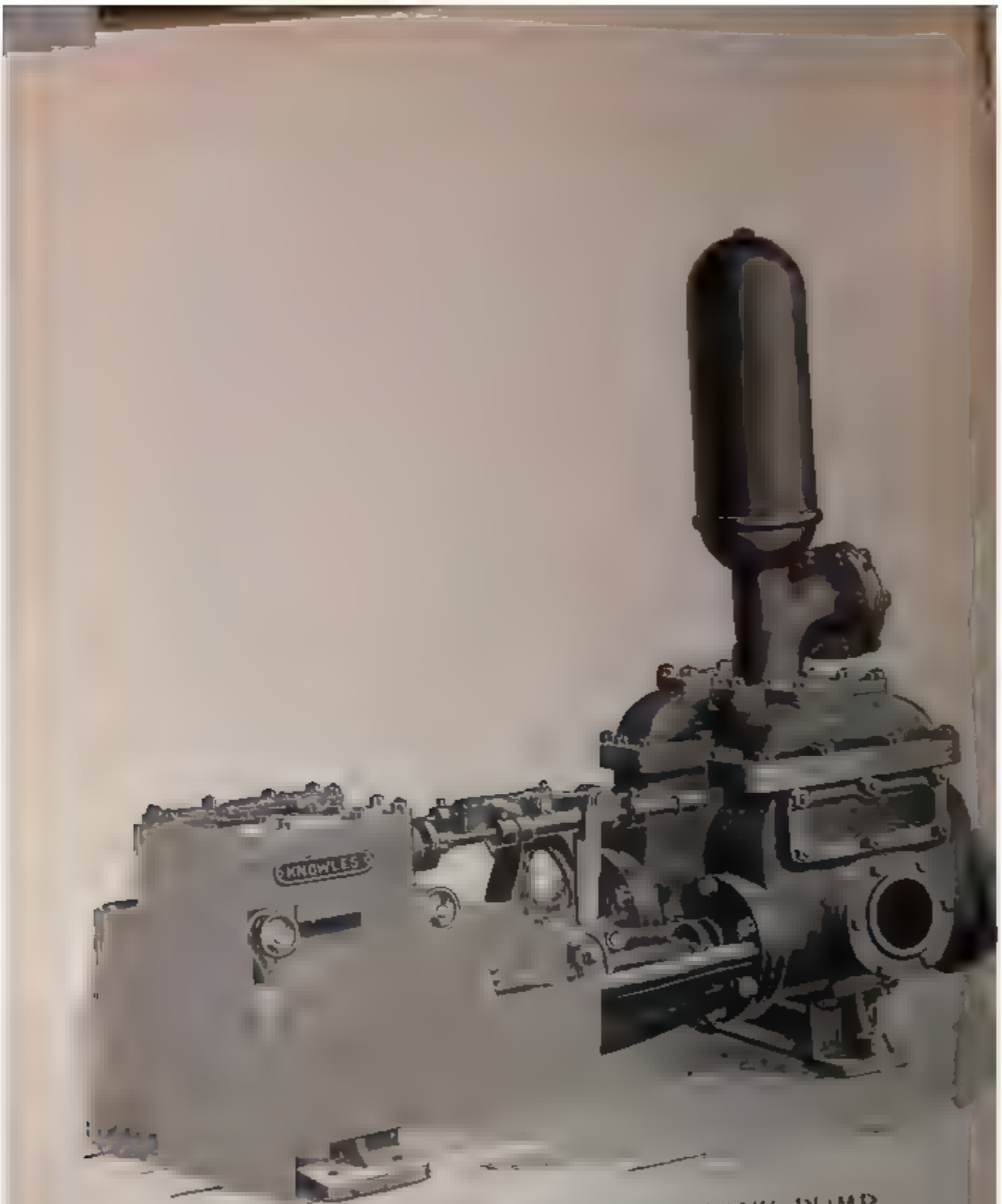
MORE THAN 300 KNOWLES PUMPING ENGINES

in operation in water works of the cities and towns of this country and abroad.

The engravings opposite show two forms of our improved Compound Condensing Duplex Pumping Engines—one having the air pump independent and the other with connected air pumps. In the former (page 92) the air pump and condenser are located on the engine-room floor conveniently near the steam cylinders of pumping engine, with an overhead feed-water heater placed in the exhaust connection between the low pressure cylinders and the condenser. In the latter (see interleaf 92½) the air pumps are placed below engine-room floor and are worked from the piston-rod cross-heads of the pumping engine. The condenser is also below, with the feed-water heater placed on an angle in the exhaust connection between the condenser and engine. This connected system of air pumps we use on the larger sizes of pumping engines. All pumping engines are provided with the most efficient system of steam jackets and other improved details.

ESTIMATES, PLANS AND SPECIFICATIONS FURNISHED ON APPLICATION.

*** When desired, we furnish our Duplex Pumping Engines provided with a very simple and effective (*patented*) device, which enables either set of cylinders to be operated independently of the other. This is the only practical and thoroughly mechanical arrangement of the kind. It requires but a few minutes to throw it into operation, and does not form any obstruction to the regular and proper working of the machinery when running regularly as duplex. This feature is an important advantage where a pumping station is not supplied with auxiliary pumping machinery, for in case of accident, or during repairs to one set of cylinders, the other set can be worked with the same *positive* and effective motion as if both were running *duplex*.



KNOWLES IMPROVED DUPLEX TANK PUMP.

REGULAR PISTON PATTERN

93—A

KNOWLES IMPROVED

DUPLEX TANK PUMPS.

FOR LIGHT SERVICE, ETC.

FOR pumping water or other liquids to limited heights and distances these pumps possess special advantages; they combine *large pumping capacity* with small expenditure of steam. They are largely used for railroad water stations and general tank supply. The steam cylinders, in proportion to the water cylinders, are made smaller in diameter than with the regular pressure pumps, consequently the first cost is less—for *amount* of water pumped. These pumps are principally used at railroad water stations, gas and oil works, bleacheries, tanneries, refineries, plantations, distilleries, etc. A variety of valves are used best adapted for pumping hot, cold, thick, thin, salt, alkaline, or other liquids. The water pistons are packed with adjustable packing of special make, and the water cylinders are brass lined.

The engraving opposite shows a Duplex Tank Pump with regular piston pattern water end. We also furnish these pumps, when desired, with regular inside plunger pattern water cylinders like the water end of duplex pump on page 90, at the same price.

SIZES, CAPACITIES AND PRICES.

Steam Cylinders. Inches.	Water Cylinders. Inches.	Stroke. Inches.	Gallons per Stroke each Piston.	Strokes per Minute of each Piston, ordinary Speed.	Capacity of both Water Cylinders at Speed stated per Minute. Gallons.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipe. Inches.	Delivery Pipe. Inches.	Price.
3	2¾	3	.08	75 to 150	15 to 24	⅜	½	2	1½	
4½	3¾	4	.23	75 to 150	36 to 72	⅜	¾	2½	1½	
4½	4½	4	.23	75 to 150	36 to 72	⅜	¾	2½	2½	
5¼	5	6	.50	75 to 125	75 to 150	¾	1¼	3	2½	
6	5¾	7	.78	75 to 125	115 to 192	1	1½	4	3	
6	5	12	1.02	50 to 100	102 to 204	1	1½	5	4	
6	6	12	1.47	50 to 100	147 to 294	1	1½	5	4	
6	8¼	7	1.75	75 to 125	262 to 436	1	1½	6	5	
7½	6	10	1.22	50 to 100	122 to 244	1½	1½	5	4	
7½	7½	10	1 91	50 to 100	192 to 392	1½	1½	6	5	
8	7	12	2 00	50 to 100	200 to 400	1½	1½	6	5	
8	8½	12	3.00	50 to 100	300 to 600	1½	1½	6	5	
8	10½	12	4.50	50 to 100	450 to 900	1½	1½	8	7	
10	8½	12	3.00	50 to 100	300 to 600	2	2½	6	5	
10	10½	12	4.50	50 to 100	450 to 900	2	2½	8	7	
10	12	12	5.87	50 to 100	587 to 1174	2	2½	10	8	
12	10½	12	4.50	50 to 100	450 to 900	2	2½	8	7	
12	12	12	5.87	50 to 100	587 to 1174	2	2½	10	8	
12	14	12	8.00	50 to 100	800 to 1600	2	2½	12	10	
14	12	12	5.87	50 to 100	587 to 1174	2½	3	10	8	
14	14	12	8.00	50 to 100	800 to 1600	2½	3	12	10	
14	14	18	12.00	40 to 70	960 to 1680	2½	3			
14	15	18	13 50	40 to 70	1090 to 1890	2½	3			
14	16	18	15.66	40 to 70	1248 to 2192	2½	3			
16	14	18	12.00	40 to 70	960 to 1680	3	3			
16	15	18	13 50	40 to 70	1090 to 1890	3	3			
16	16	18	15.66	40 to 70	1248 to 2192	3	3			

ALSO PATTERNS FOR LARGER SIZES AND OTHER COMBINATIONS.

Pumps Fitted with Composition Piston Rods, etc., at a slight additional charge.

Auxiliary Boiler-Feed Pumps (single-acting plungers) attached, when ordered, at a slight additional charge.

☞ In ordering Duplex Pumps parties will please state fully the duty to be performed, *i. e.*, the elevation the water has to be pumped and the length and diameter of suction and discharge pipes, etc.

KNOWLES SPECIAL DUPLEX TANK PUMP.

Size 8x10¼x12

[redacted]

The Knowles Special Duplex Pump.

Tank, or Light Service Pattern.

— —

5E pumps are designed for use where the liquid handled is to be raised only to moderate height. They are made of the piston pattern, pump pistons fibrous and they are furnished with valves of hard or soft rubber, or of metal, as required, g to the liquid to be handled. Water cylinders are brass lined.

Stroke. Ins.	Capacity in Gallons per Stroke, each Piston.	Strokes per Minute, each Piston.	Capacity of Both Cylinders, in Gallons, per Minute.	Steam Pipe Ins.	Exhaust Pipe Ins.	Suction Pipe. Ins	Discharge Pipe. Ins	Telegraphic Code Word. Regular.	Brass Fitted.
4	.20	100 to 200	40 to 80	½	¾	2½	1½	Geese	Genoemd
5	.38	100 " 150	75 " 110	¾	1¼	3	2½	Gelable	Genoessig
6	.67	100 " 150	130 " 195	1	1½	4	3	Gelatine	Genoethigt
6	1.14	100 " 150	225 " 340	1	1½	6	5	Gelding	Genoffel
6	.73	100 " 150	146 " 220	1¼	1½	4	3	Gelidity	Genoillerć
6	1 14	100 " 150	225 " 340	1¼	1½	6	5	Geminate	Genoodigd
6	1.47	100 " 150	295 " 440	1	1½	6	5	Gemmary	Genoper
6	1.47	100 " 150	295 " 440	1¼	1½	6	5	Gemmated	Genoplesio
10	1.22	75 " 125	180 " 300	1¼	1½	5	4	Gemmule	Genopt
10	1.66	75 " 125	245 " 410	1¼	1½	6	5	Gendarme	Genosiride
10	1.66	75 " 125	245 " 410	1½	2	6	5	Gender	Genovesas
10	1.91	75 " 125	285 " 475	1½	2	6	5	Genearch	Genoveva
10	2.45	75 " 125	365 " 610	1¼	1½	6	5	General	Genrebild
10	2 45	75 " 125	365 " 610	1½	2	6	5	Generant	Genteelish
10	2 45	75 " 125	365 " 610	1½	2	6	5	Generate	Genterella
10	3.57	75 " 125	530 " 890	1½	2	8	7	Generating	Gentezuma
10	3.57	75 " 125	530 " 890	1½	2	8	7	Generic	Genthios
10	3.75	75 " 125	560 " 935	2½	3	8	7	Generical	Genthite
10	3.75	75 " 125	560 " 935	2½	3	8	7	Generosity	Genticae
10	4.89	75 " 125	730 " 1220	1½	2	10	8	Generous	Genticorum
10	4.89	75 " 125	730 " 1220	2½	3	10	8	Genesis	Genticum
10	4.89	75 " 125	730 " 1220	2½	3	10	8	Genetic	Gentilibus
10	6.66	75 " 125	990 " 1660	1½	2	12	10	Genevan	Gentilino
10	6.66	75 " 125	990 " 1660	2½	3	12	10	Genevese	Gentilismo
10	6.66	75 " 125	990 " 1660	2½	3	12	10	Genially	Gentilitas

ALSO PATTERNS FOR LARGER SIZES

slight additional charge is made when pumps are fitted with brass pistons and ston rods.

designate the sizes give the diameter of steam and water cylinders, and length e, or use code word.

KNOWLES COMBINED DUPLEX PUMP AND BOIL

WITH FIXTURES, ETC.

[redacted]

THE KNOWLES COMBINED SPECIAL
DUPLEX PUMP AND BOILER.

REGULAR UPRIGHT TUBULAR BOILER.

COMPLETE WITH AUXILIARY BOILER FEED PUMP, BASE PLATE, SMOKE BONNET, GRATE BARS, GAUGE COCKS, STEAM GAUGE, WATER GAUGE, SAFETY VALVE, GLOBE VALVES, BLOW-OFF COCKS, STEAM AND EXHAUST PIPES, BOILER FEED CONNECTION, VALVES, UNIONS AND NECESSARY FITTINGS, ETC.

THIS combination of Duplex Steam Pump, with upright tubular boiler and fixtures complete is the most compact, serviceable and inexpensive machine of its kind for supplying water to hotels, public buildings, and residences; also for use at railroad water stations, brick-yards, tanneries, quarries, plantations, etc.

The attention of plantation owners is particularly called to the especial advantage of this light, portable, and convenient pumping apparatus for the water supply for irrigating purposes, etc. The entire machine can be placed at the point from which the water is to be taken, and the water forced to any distance and height required.

The whole apparatus is of the best manufacture, the boiler being perfectly safe and guaranteed to 100 pounds pressure (tested to 200 pounds) per square inch When water is to be forced not higher than 50 to 75 feet, the "Tank Pumps" are preferable and less expensive Auxiliary Plunger Pumps, for feeding the boilers are attached to all light service pumps without additional charge.

REGULAR PATTERN FOR GENERAL SERVICE

Steam Cylinders.	Water Cylinders.	Stroke.	Gallons per Stroke. Each Piston.	Strokes per Minute, Each Piston	Capacity of Both Cylinders at Speed stated per Minute.	Steam Pipe	Exhaust Pipe	Suction Pipe	Delivery Pipe	Telegraphic Code Word
Inches	Inches	Ins			Gallons.	Ins.	Ins	Ins.	Ins	
3	2	3	.04	100 to 250	8 to 20	⅜	½	1¼	1	Gladden
4½	2¾	4	.10	100 " 200	20 " 40	½	¾	2	1½	Gladding
5¼	3½	5	.20	100 " 200	40 " 80	¾	1¼	2½	1½	Gladly
6	4	6	.33	100 " 150	66 " 100	1	1½	3	2	Gladness
7½	4½	6	.42	100 " 150	85 " 125	1½	2	4	3	Gladsome
7½	5	6	.51	100 " 150	100 " 150	1½	2	4	3	Gladwin
7½	4½	10	.69	75 " 125	100 " 170	1½	2	4	3	Glamour
9	5¼	10	.93	75 " 125	135 " 230	2	2½	4	3	Glance
10	6	10	1.22	75 " 125	180 " 300	2	2½	5	4	Glancing

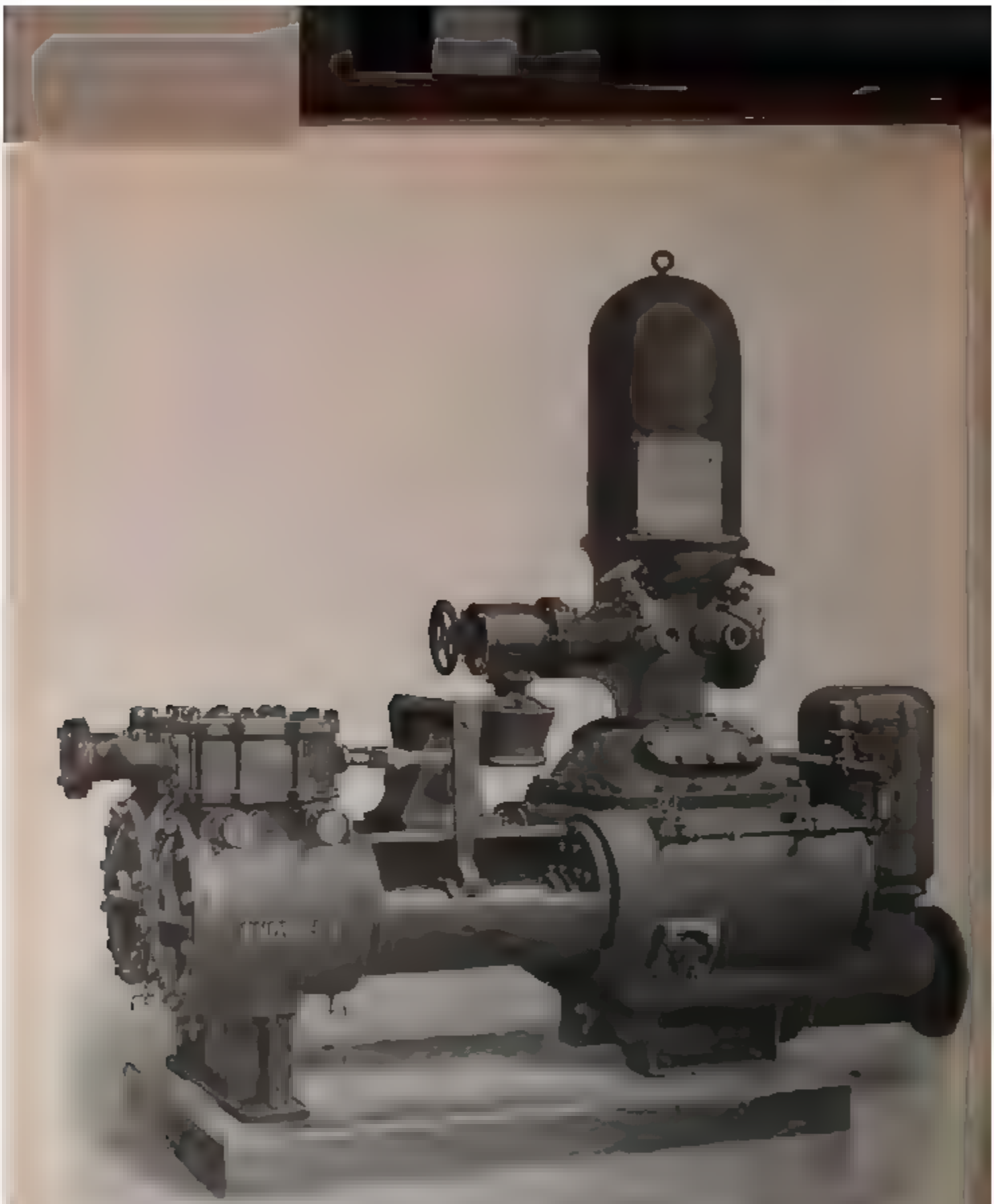
TANK OR "LIGHT SERVICE" PUMPS

4½	3¾	4	.20	100 to 200	40 to 80	½	¾	2½	1½	Glanders
5¼	4¾	5	.38	100 " 150	75 " 110	¾	1¼	3	2½	Glandule
6	5¼	6	.67	100 " 150	130 " 195	1	1½	4	3	Glaring
6	7½	6	1.14	100 " 150	225 " 340	1	1½	6	5	Glassy
7½	7½	6	1.14	100 " 150	225 " 340	1½	2	6	5	Glazier
9	8½	6	1.47	100 " 150	295 " 440	1	1½	6	5	Gleaming
7½	[redacted]	0	1.22	75 " 125	180 " 300	1½	2	5	4	Gleaner
7½	7	10	1.66	75 " 125	245 " 410	1½	2	6	5	Glebe
7½	8½	10	2.45	75 " 125	365 " 610	1½	2	6	5	Gleeful
10	8½	10	2.45	75 " 125	365 " 610	2	2½	6	5	Gleety

ALSO PATTERNS FOR LARGER SIZES.

A slight additional *charge is made when pumps are fitted with brass pistons or plungers, and brass piston rods.*
To designate the sizes, give the diameter of steam and water cylinders and length of stroke, or use code word.

3680804



THE KNOWLES UNDERWRITER FIRE PUMP.

Size 18x 0x12

1000 gallons per minute

THE KNOWLES
UNDERWRITER FIRE PUMP.

MUTUAL INSURANCE COMPANIES' SPECIFICATIONS.

IN our Underwriter Fire Pump, the water passages, valve areas, and suction and discharge nozzles are all much larger than in any ordinary pump, so a greater amount of water can be discharged without water-hammer. Also, the steam and exhaust ports and nozzles are designed so as to give unrestricted passage to the steam. The pump is "rust-proof," and will start instantly, after standing unused for a long time. The piston rods and valve rods are made from Tobin bronze. All stuffing-boxes and glands are brass lined. Plungers and plunger sleeve are of composition, but the metals are differently mixed to prevent cutting. This mixture of the metals has been a subject of much experiment and study; it has now brought us great success, as the parts work perfectly upon each other, without friction or impairment.

Each pump has the following fittings, heretofore charged as extras, but now included in the price and regularly furnished:

Capacity-Plate on Discharge Air-Chamber.
Stroke-Gauge, graduated on each end.
Vacuum, or Suction Air-Chamber.
Steam-Gauge, 5 inches diameter.
Water-Gauge, 5 inches diameter, with duplex spring.
Relief-Valve of large capacity.
Relief-Valve Discharge-Cone.
Set of brass priming Pipes and special valves.
Required number of 2½ inches Ludlow Hose-Valves.
One pint Sight-Feed Cylinder-Lubricator.
All according to the specifications.

On account of the larger passageways, brass parts and attachments mentioned, the pump necessarily costs more than an ordinary fire pump; but the cost by the gallon discharged is less, since the Underwriter pump can deliver a greater quantity of water in the same length of time. It is also much heavier and stronger, with superior workmanship, and better protected from rust and accident.

TABLE OF SIZES AND CAPACITIES.

Diameter of Steam Cylinders.	Diameter of Water Plungers.	Length of Stroke.	Normal Capacities, Gallons per Minute.	Number of Fire Streams.	Steam Pipe.	Exhaust Pipe.	Suction Pipe.	Discharge Pipe.	Code Word.
12	6	12	320	1	2½	3	6	5	Ensign
14	7¼	12	500	2	3	4	8	6	Ensigncy
16	9	12	750	3	3½	4	10	7	Enskied
18	10	12	1000	4	4	5	12	8	Enslave
20	12	16	1500	6	5	6	14	10	Ensnarl

The actual capacity of each pump is more than the Underwriters' rating, and a greater speed can be attained, that will increase the number of fire streams.

KNOWLES SPECIAL DUPLEX PUMP.

OUTSIDE PACKED PLUNGER PATTERN

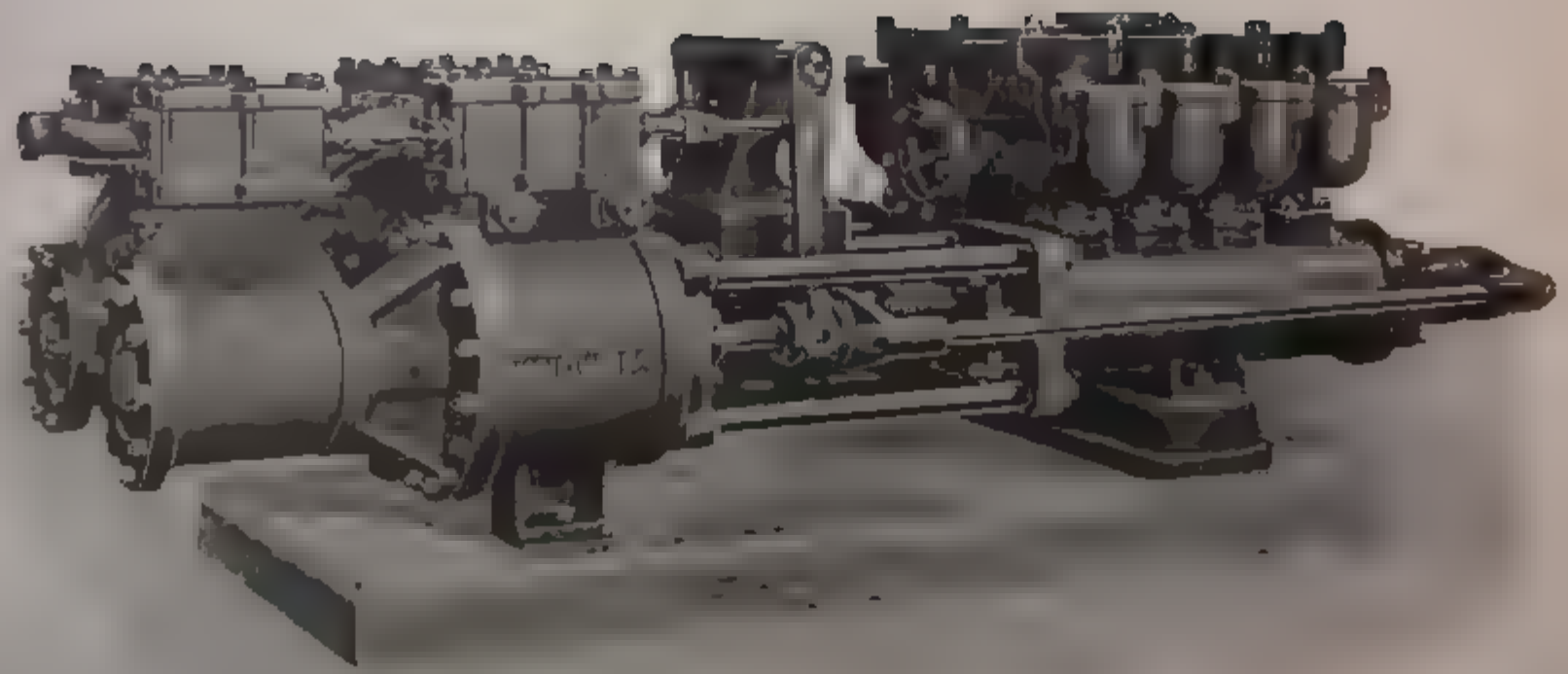
Size, 6¼x5x5

THE KNOWLES
SPECIAL DUPLEX PUMP.

OUTSIDE PACKED PLUNGER PATTERN.

115 pattern of pump is specially designed for pipe lines, for mining purposes, for feeding boilers carrying very high steam pressures in conformity with the most modern practice, or for any service requiring the delivery of liquids under unusually heavy pressure, not to exceed 250 to 450 pounds per square inch. Owing to the facility with which wear in the water plungers may be taken up, by setting out the packing in the g boxes, these pumps are specially well suited for handling gritty liquids

Indera	Water Plungers Ins	Stroke. Ins	Capacity, in Gallons, per Stroke Each Plunger	Strokes, per Minute, Each Plunger	Capacity of Both Cylinders, in Gallons, per Minute	Steam Pipe Ins.	Exhaust Pipe Ins	Suction Pipe Ins	Discharge Pipe Ins	Water Press. Pump End will stand, in lbs. per sq. in	Telegraphic Code Word
	2	3	.04	100 to 200	8 to 16	½	¾	1½	1¼	300	Gialder
2	2	4	.05	100 " 200	10 " 20	½	¾	1½	1¼	300	Giant
2	3	5	.15	100 " 200	30 " 60	¾	1¼	2	1½	300	Giantess
	3½	[redacted]	.25	100 " 150	50 " 75	1	1½	2½	2	300	Gibbed
5	4	6	.33	100 " 150	67 " 100	1½	2	3	2½	300	Gibbering
5	4¼	10	.61	50 " 100	61 " 122	1½	2	4	3	300	Gibberish
	4	10	.54	50 " 100	54 " 108	2	2½	4	3	250	Gibbet
	4	10	.54	50 " 100	54 " 108	2	2½	4	3	450	Gibbous
	5	10	.85	50 " 100	85 " 170	2	2½	4	3	250	Giddily
	5	12	1.02	50 " 100	102 " 204	2	2½	4	3	250	Giddy
	6	10	1.22	50 " 100	122 " 244	2	2½	5	4	250	Giebelgeld
	6	12	1.47	50 " 100	147 " 294	2	2½	5	4	250	Giebelmoos
	4	10	.54	50 " 100	54 " 108	2½	3	4	3	150	Giedroyc
	4	12	.65	50 " 100	65 " 130	2½	3	4	3	450	Giegelde
	5	10	.85	50 " 100	85 " 170	2½	3	4	3	300	Gieksjzers
	5	12	1.02	50 " 100	102 " 204	2½	3	4	3	300	Gienaffe
	6	10	1.22	50 " 100	122 " 244	2½	3	5	4	300	Gienmaul
	6	12	1.47	50 " 100	147 " 294	2½	3	5	4	300	Giereklauw
	7	10	1.66	50 " 100	166 " 332	2½	3	6	5	300	Gierende
	7	12	2.00	50 " 100	200 " 400	2½	3	6	5	300	Gierenoog
	7½	10	1.91	50 " 100	191 " 382	2½	3	6	5	300	Giereveder
	7½	12	2.30	50 " 100	230 " 460	2½	3	6	5	300	Giergaard
	5	10	.85	50 " 100	85 " 170	2½	3	4	3	300	Gierpont
	5	12	1.02	50 " 100	102 " 204	2½	3	4	3	300	Gierput
	6	10	1.22	50 " 100	122 " 244	2½	3	5	4	300	Giersch
	6	12	1.47	50 " 100	147 " 294	2½	3	5	4	300	Gierstjes
	6	18	2.20	40 " 80	176 " 352	2½	3	6	5	450	Giervalk
	7	10	1.66	50 " 100	166 " 332	2½	3	6	5	300	Gierzwaluw
	7	12	2.00	50 " 100	200 " 400	2½	3	6	5	300	Giessbad
	7	18	3.00	40 " 80	240 " 480	2½	3	7	6	450	Giessen
	7½	10	1.91	50 " 100	191 " 382	2½	3	6	5	300	Giesskelle
	7½	12	2.30	50 " 100	230 " 460	2½	3	6	5	300	Giessmodel
	8	10	2.18	50 " 100	218 " 436	2½	3	7	6	300	Giesstisch
	8	12	2.61	50 " 100	261 " 522	2½	3	7	6	300	Giestal
	8	18	3.91	40 " 80	312 " 625	2½	3	8	7	450	Gietbaden
	8⅛	18	4.50	40 " 80	360 " 720	2½	3	8	7	400	Gietemmers
	9	12	3.30	50 " 100	330 " 660	2½	3	8	7	250	Gieterijen
	9	18	4.95	40 " 80	396 " 792	2½	3	8	7	250	Giethuizen
	5	10	.85	50 " 100	85 " 170	3	4	4	3	450	Gietkan



THE KNOWLES COMPOUND SPECIAL DUPLEX PUMP.

Outside Packed Plunger Pattern

Size, [illegible]

[redacted]

THE KNOWLES SPECIAL DUPLEX PUMP—CONTINUED.

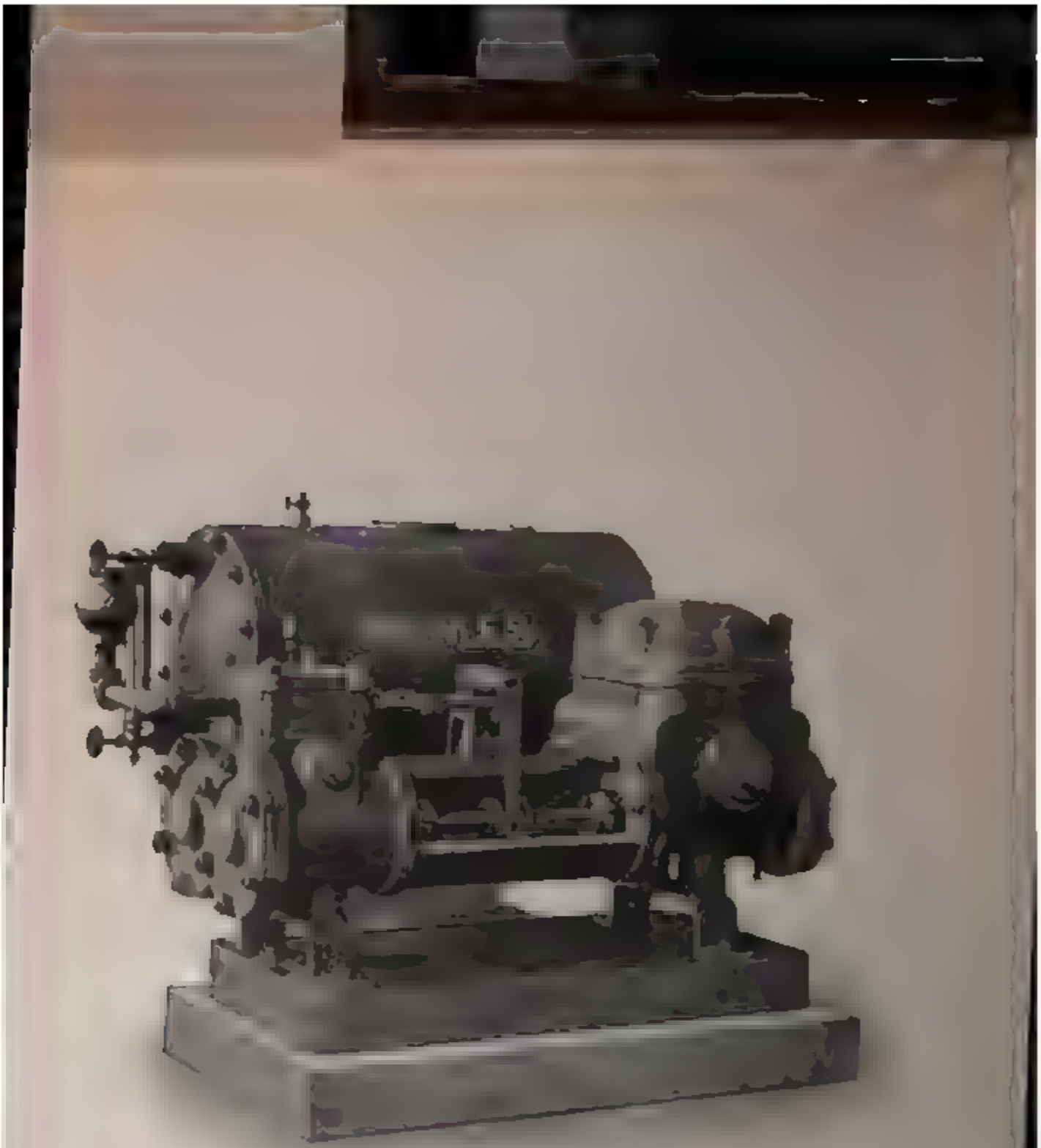
Steam Cylinders.	Water Plungers.	Stroke.	Capacity, in Gallons, per Stroke, Each Plunger.	Strokes per Minute, Each Plunger.	Capacity of Both Cylinders, in Gallons, per Minute.	Steam Pipe.	Exhaust Pipe.	Suction Pipe.	Discharge Pipe.	Water Press. Pump Will stand, in lbs. per sq. in.	Telegraphic Code Word.
Ins.	Ins.	Ins.				Ins.	Ins.	Ins.	Ins.		
16	5	12	1.02	50 to 100	102 to 204	3	4	4	3	450	Gietketel
16	6	10	1.22	50 " 100	122 " 244	3	4	5	4	450	Gietkunst
16	6	12	1.47	50 " 100	147 " 294	3	4	5	4	450	Gietnaad
16	6	18	2.20	40 " 80	176 " 352	3	4	6	5	450	Gietsel
16	7	10	1.66	50 " 100	166 " 332	3	4	6	5	300	Giettafels
16	7	12	2.00	50 " 100	200 " 400	3	4	6	5	300	Giettappen
16	7½	10	1.91	50 " 100	191 " 382	3	4	6	5	300	Gietvorm
16	7½	12	2.30	50 " 100	230 " 460	3	4	6	5	300	Giffleras
16	7	18	3.00	40 " 80	240 " 480	3	4	7	6	450	Giffleront
16	7½	18	3.44	40 " 80	275 " 550	3	4	7	6	450	Giftappels
16	8	10	2.18	50 " 100	218 " 436	3	4	7	6	300	Giftbecher
16	8	12	2.61	50 " 100	261 " 522	3	4	7	6	300	Giftblase
16	8	18	3.91	40 " 80	312 " 625	3	4	8	7	450	Giftdamp
16	8⅛	18	4.50	40 " 80	360 " 720	3	4	[redacted]	7	400	Giftedness
16	9	12	3.30	50 " 100	330 " 660	3	4	8	7	250	Gifterz
16	9	18	4.95	40 " 80	396 " 792	3	4	8	7	250	Giftgruen
18½	7	10	1.66	50 " 100	166 " 332	3	4	6	5	250	Gifthaus
18½	7	12	2.00	50 " 100	200 " 400	3	4	6	5	250	Giftigheid
18½	7	10	1.66	50 " 100	166 " 332	3	4	6	5	350	Giftigsten
18½	7	12	2.00	50 " 100	200 " 400	3	4	6	5	350	Giftkrabbe
18½	7½	10	1.91	50 " 100	191 " 382	3	4	6	5	300	Giftkugel
18½	7½	12	2.30	50 " 100	230 " 460	3	4	6	5	300	Giftmittel
18½	8	10	2.18	50 " 100	218 " 436	3	4	7	6	250	Giftpfeil
18½	8	10	2.18	50 " 100	218 " 436	3	4	7	6	450	Giftrinne
18½	8	12	2.61	50 " 100	261 " 522	3	4	7	6	250	Giftsack
18½	8	12	2.61	50 " 100	261 " 522	3	4	7	6	450	Giftspitz
18½	8	18	3.91	40 " 80	312 " 625	3	4	8	7	450	Giftstein
18½	8⅛	18	4.50	40 " 80	360 " 720	3	4	8	7	400	Gifttanden
18½	9	18	4.95	40 " 80	396 " 792	3	4	8	7	250	Gifttrank
18½	10	12	4.08	50 " 100	408 " 816	3	4	10	8	250	Giftwerend
18½	10	18	6.12	40 " 80	490 " 980	3	4	10	8	250	Giftzahn
20	8	12	2.61	50 " 100	261 " 522	4	5	7	6	450	Gigajoga
20	8	18	3.91	40 " 80	312 " 625	4	5	8	7	450	Gigantessa
20	8⅛	18	4.50	40 " 80	360 " 720	4	5	8	7	400	Gigantical
20	9	12	3.30	50 " 100	330 " 660	4	5	8	7	250	Gigantino
20	9	18	4.95	40 " 80	396 " 792	4	5	8	7	250	Gigantone
20	10	12	4.08	50 " 100	408 " 816	4	5	10	8	250	Giggets
20	10	18	6.12	40 " 80	490 " 980	4	5	10	8	250	Gigiozzo

ALSO PATTERNS FOR LARGER SIZES.

For mining work, when so ordered, suction opening will be made same diameter as plunger, except 7½ inches and 8⅛ inches, which will be made 7 inches and 8 inches diameter respectively. Discharge opening will be for next smaller size pipe than suction pipe. A slight additional charge made when pumps fitted with brass plungers. To designate the sizes, give the diameter of steam and water cylinders and length of stroke, use code word. We have also patterns for pumps of the above type suited for much heavier pressures than those named in the table. For these we will quote special prices on application.

COMPOUND DUPLEX PLUNGER PUMPS. CONDENSING AND NON-CONDENSING.

We have patterns from new and improved designs, embodying all the latest improvements, for different sizes of Duplex Plunger Pumps built on the compound plan, as illustrated on opposite page. They will work under the heaviest pressures, with the *minimum* consumption of steam. *Estimates given on application.*



KNOWLES AUTOMATIC FEED PUMP AND RECEIVER.

Size 6x4x6

and returns the condensed steam [illegible]
is it accumulates in the receiver. It [illegible]
and entirely prevents all snapping and [illegible]
he use of traps having intermittent action. The Automatic Steam Pump and
iver can be used for other purposes than a boiler feed appliance, for instance for
ating the brine circulation in refrigerating machinery, for the temperate apparatus
er cooling and for other circulating purposes.

This apparatus also makes an efficient form of governor for maintaining a uniform
r level in steam heating systems. When used for this purpose the receiver is
d at the height at which it is required to maintain the water line. When desired
eceiver and pump may be separated, the receiver being placed at the water line
, and the pump located below at any convenient point.

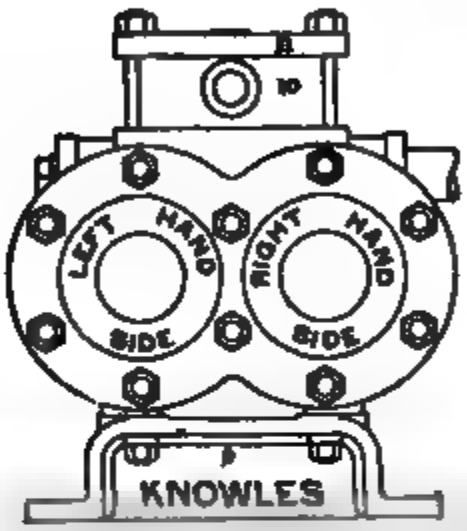
Referring to the illustration on the opposite page, it will be noticed that the con-
ed steam enters by the inlet nozzle at the top, and falls to the bottom of the receiver
water cannot accumulate in any quantity, as in rising it lifts the float and the
n pump takes it away immediately and forces it to the boiler. The pump is operated
the float by means of the intermediate connections, and being a steam pump
n the float rises the pump is started, and the speed is regulated according to the
ntity of water flowing into the receiver—the larger the quantity of water the faster
pump moves. The pump slows down as the supply of water drops off, and when it
es the pump stops entirely.

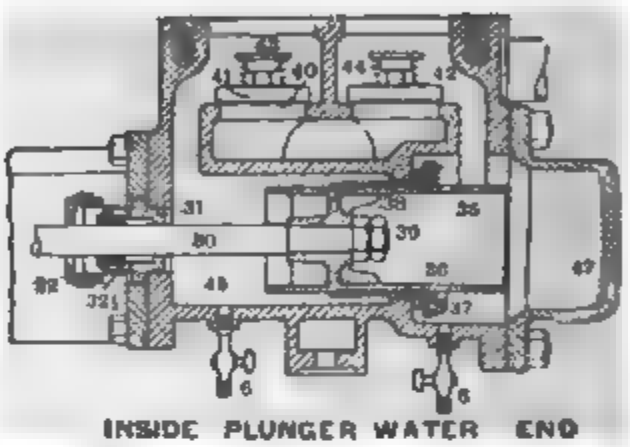
a.	Gallons Delivered per Minute.	Square Feet of Radiating Surface it will Drain.	Space Occupied			Order Word.
			Length.	Width.	Height.	
1	12	5,000	36 inches	25 inches	22 inches	Gibly

[redacted]

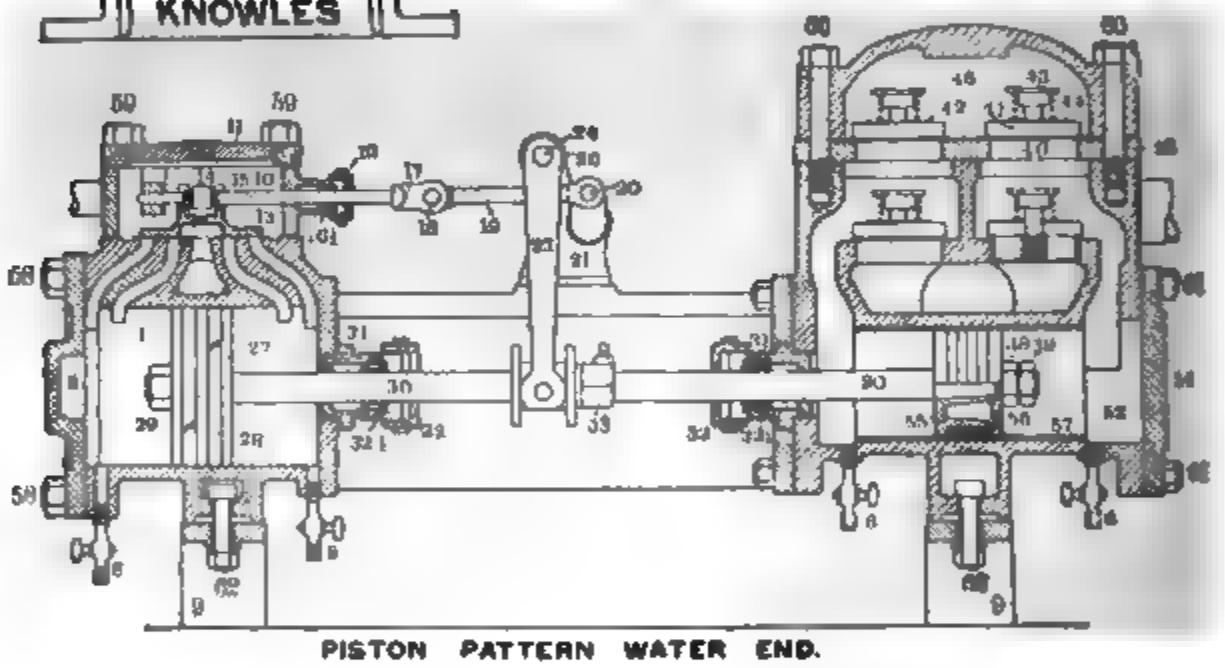
NUMBERED LIST OF PARTS OF KNOWLES SPECIAL DUPLEX PUMPS.

6-INCH STROKE AND UNDER.

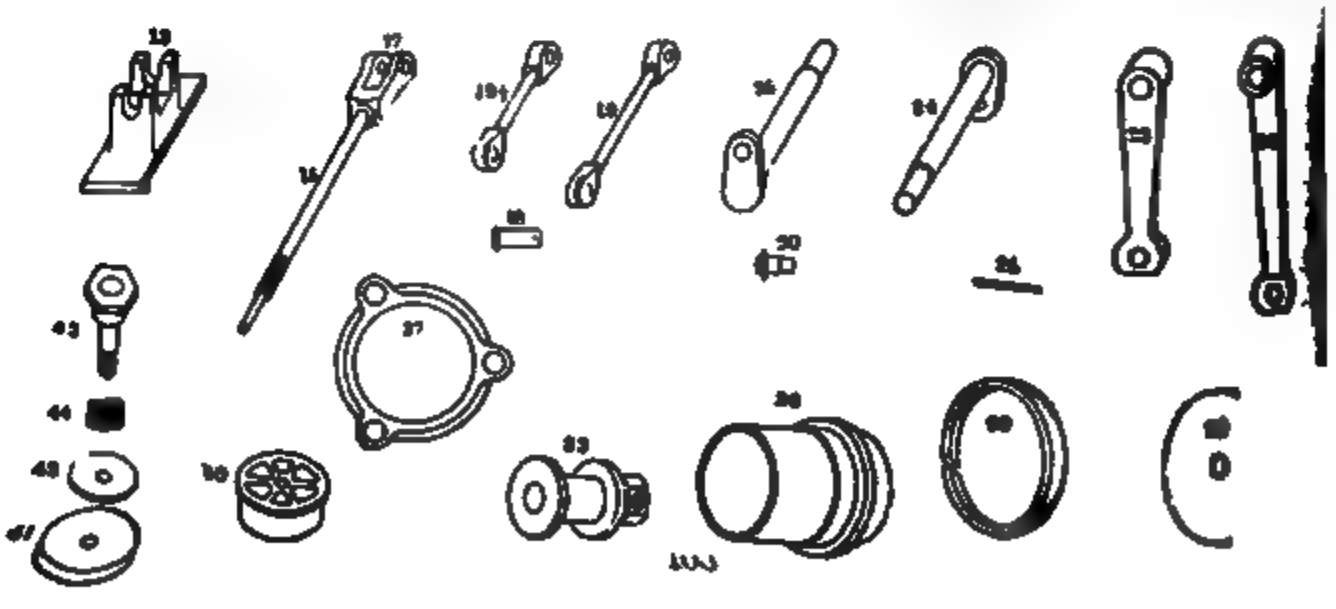




INSIDE PLUNGER WATER END



PISTON PATTERN WATER END.



[redacted]

OF SPECIAL DUPLEX PUMPS, SIX INCH STROKE AND UNDER

and numbered on the opposite page. Customers in ordering parts, to will please state the size of their pump and the Manufacturers' Serial ıg list of the parts desired, with their respective names or numbers. For ng **Manufacturers' Serial Number** see page 115.

LIST OF PARTS.

nders, right or left.
, steam and water ends.
nder Head.
:eam and water cylinders.
st.
st Cover.
.
Nut.

stuffing Box Cap.
l Stuffing Box Follower.
aw.
aw Pin.

ık.
ınd Washer.

.
r.
t.
t.

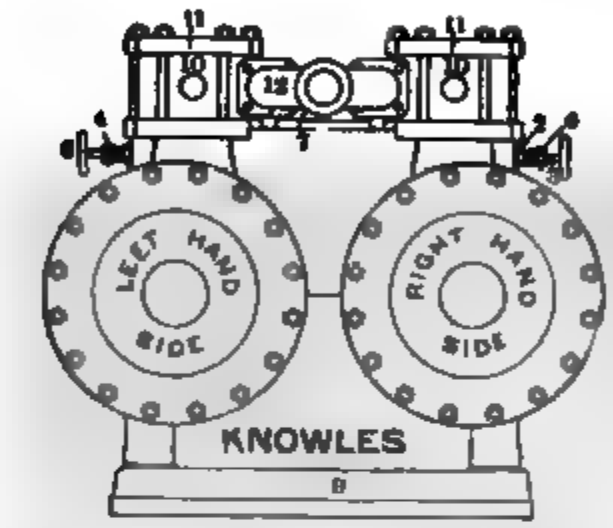
ɔn.
ɔn Rings.
ɔn Nut.
.
Stuffing Box.
Stuffing Box Cap.

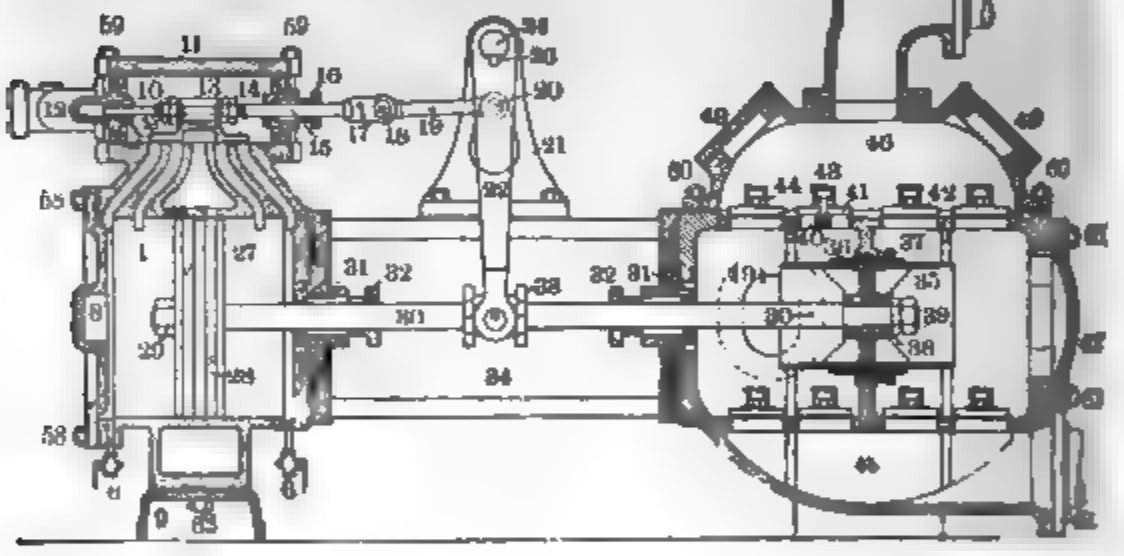
32½. Piston Rod Stuffing Box Follower
33. Spool, and Setscrew.
35. Plunger.
36. Plunger Sleeve.
37. Binder.
38. Plunger Jam Nut.
39. Plunger Nut.
40. Valve Seat.
41. Valve.
42. Valve Backing.
43. Valve Bolt.
44. Valve Spring.
45. Plunger Pump Cylinder.
46. Pump Cap.
47. Plunger Pump Head.
52. Piston Pump Cylinder.
53. Valve Plate.
54. Piston Pump Head.
55. Water Piston.
56. Piston Follower.
57. Water Cylinder Lining.
58. Steam Cylinder Head Studs and Nuts.
59. Steam Chest holding down Studs and Nuts.
60. Water Cap Studs and Nuts.
61. Water Cylinder Head Studs and Nuts.
62. Bolts and Nuts for Steam and Water Cylinder Feet.

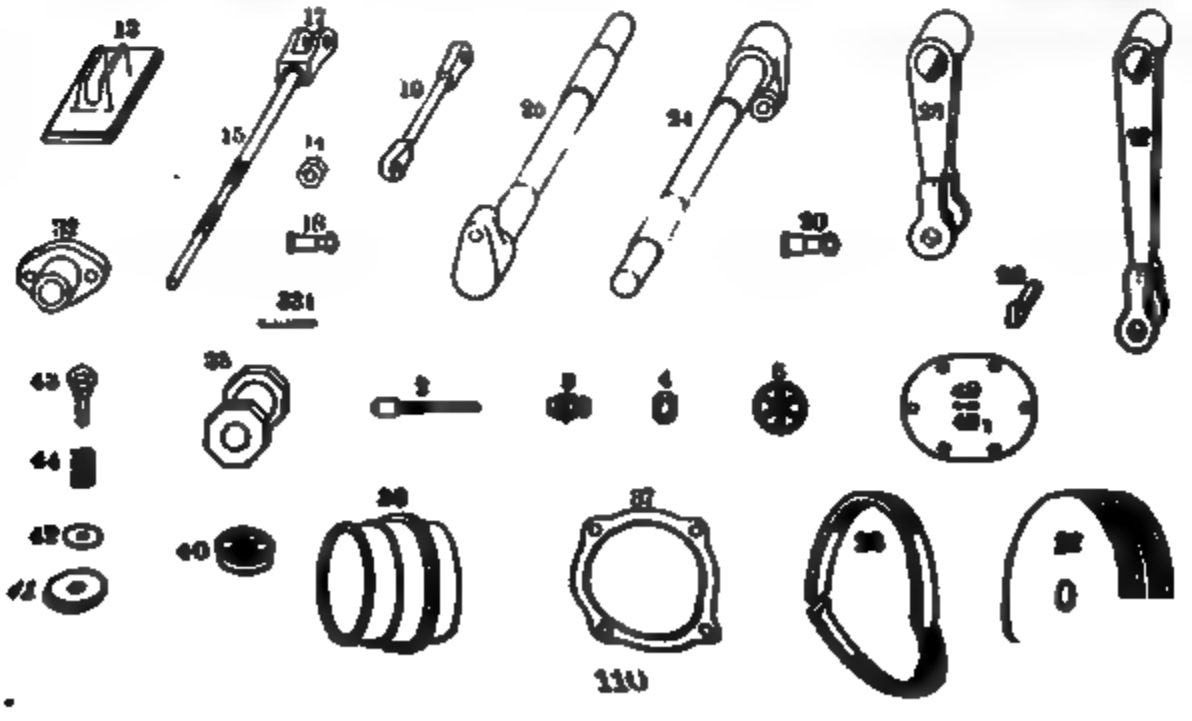
[redacted]

NUMBERED LIST OF PARTS OF KNOWLES SPECIAL DUPLEX PUMPS.

10-INCH STROKE AND OVER.







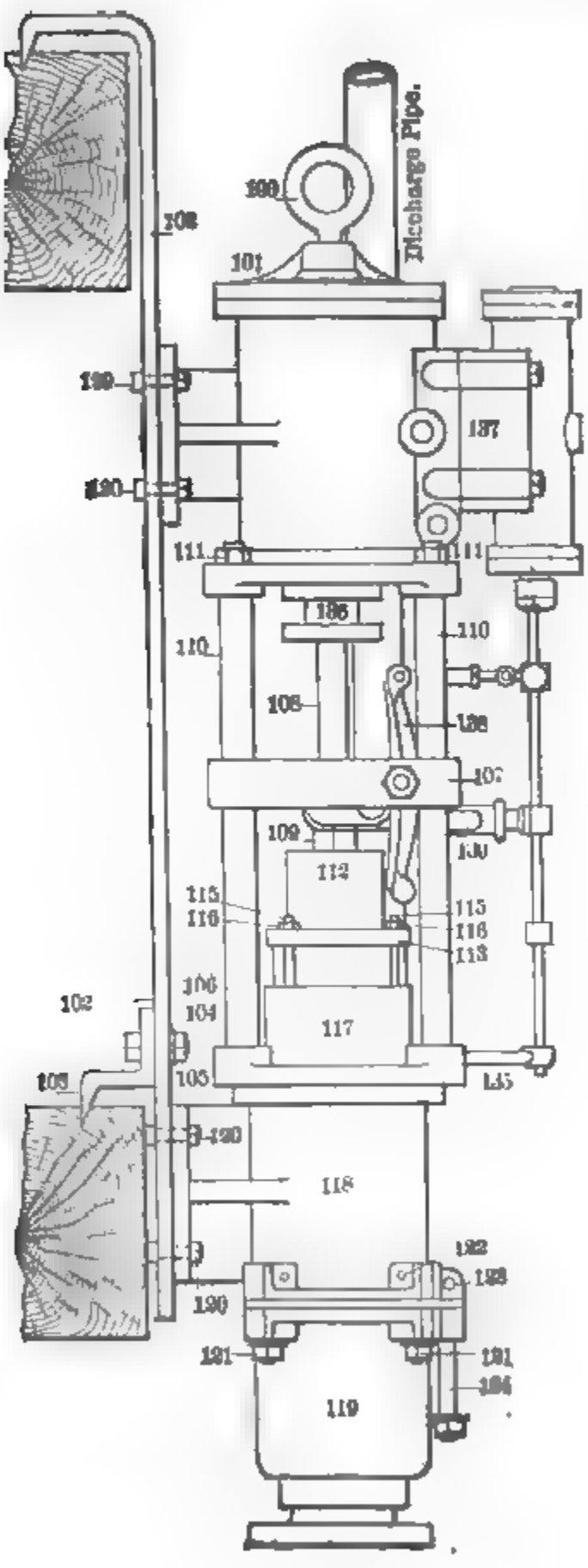
PARTS OF SPECIAL DUPLEX PUMPS, TEN INCH STROKE AND OVER

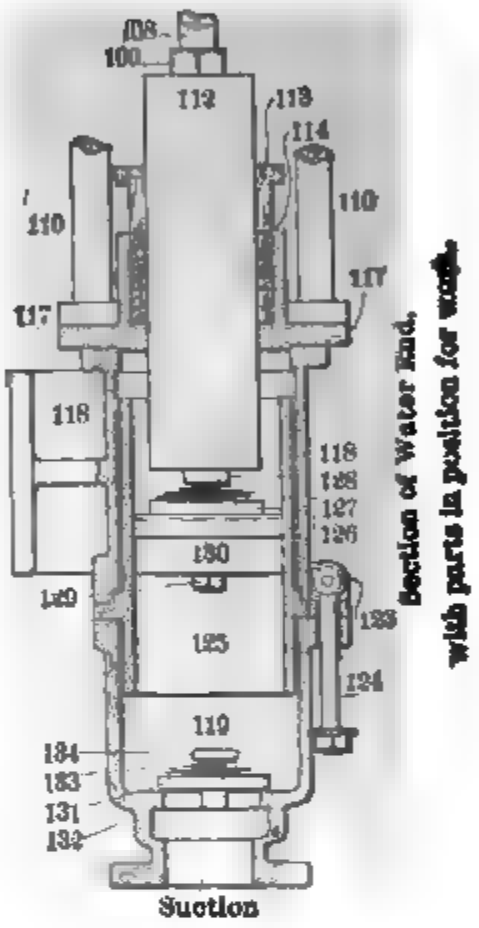
are illustrated and numbered on the opposite page. Customers in ordering parts, to avoid mistakes, will please state the size of their pump and the **Manufacturers' Serial Number,** giving list of the parts desired, with their respective names or numbers. For method of finding **Manufacturers' Serial Number** see page 115.

LIST OF PARTS.

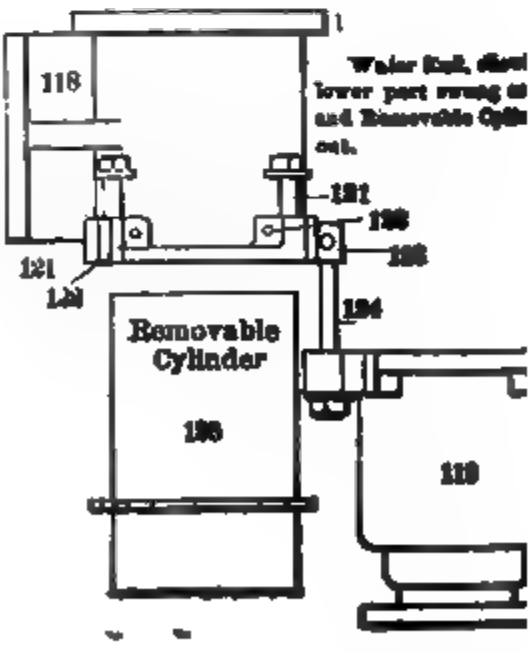
1. Right or left Steam Cylinder.
2. Cushion Valves.
3. " " Stem.
4. " " " Cap.
5. " " Hand Wheel.
6. Drip Cocks, Steam end.
7. Flange for Exhaust Pipe.
8. Steam Cylinder Heads.
9. Steam Cylinder Foot.
10. Steam Chests.
11. Steam Chest Covers.
12. Steam Pipe.
13. Slide Valve.
14. Valve-rod Nuts.
15. Valve-rod.
16. Valve-rod Stuffing Box Gland.
17. Valve-rod Jaw.
18. Valve-rod Jaw Pin.
19. Link (long).
19½. Link (short).
20. Crank Pins.
21. Pedestal.
22. Long Lever.
23. Short Lever.
24. Upper Rock Shaft.
25. Lower Rock Shaft.
26. Keys for Rock Shafts.
27. Steam Piston.
28. Steam Piston Rings.
29. Steam Piston-rod Nut.
30. Piston-rod.
31. Piston-rod Stuffing Box.
32. Piston-rod Gland.
33. Spool.
33½. Spool Pin.
34. Centre.
35. Plunger.
36. Plunger Sleeve, or Renewable Lining.
37. Binder.
38. Plunger Jam Nut.
39. Plunger Nut.
40. Valve Seat.
41. Valves.
42. Valve Backings.
43. Valve Bolt.
44. Valve Spring.
45. Pump Cylinder.
46. Pump Cylinder Cap.
47. Pump Cylinder Heads.
48. Discharge Elbow, and Air Chamber.
49. Hand-hole Plates for Discharge Valves.
49½. " " " Suction Valves.
50. Discharge Screw Flange.
51. Suction Screw Flange.
58. Steam Cylinder Head Studs and Nuts.
59. Steam Chest holding down Studs and Nuts.
60. Water Cap Studs and Nuts.
61. " Cylinder Head Studs and Nuts.
62. Bolts and Nuts for Steam and Water Cylinder Feet.

NUMBERED LIST OF PARTS OF KNOWLES SINKING PUMPS.





KNOWLES
BUCKET-PLUNGER SINKING PUMP.



PARTS OF KNOWLES SINKING PUMPS

are illustrated and numbered on the opposite page. Customers in ordering parts, to avoid mistakes, will please state the size of their pump, and the **Manufacturers' Serial Number,** giving list of the parts desired, with their respective names or numbers. For method of finding **Manufacturers' Serial Number,** see page 115.

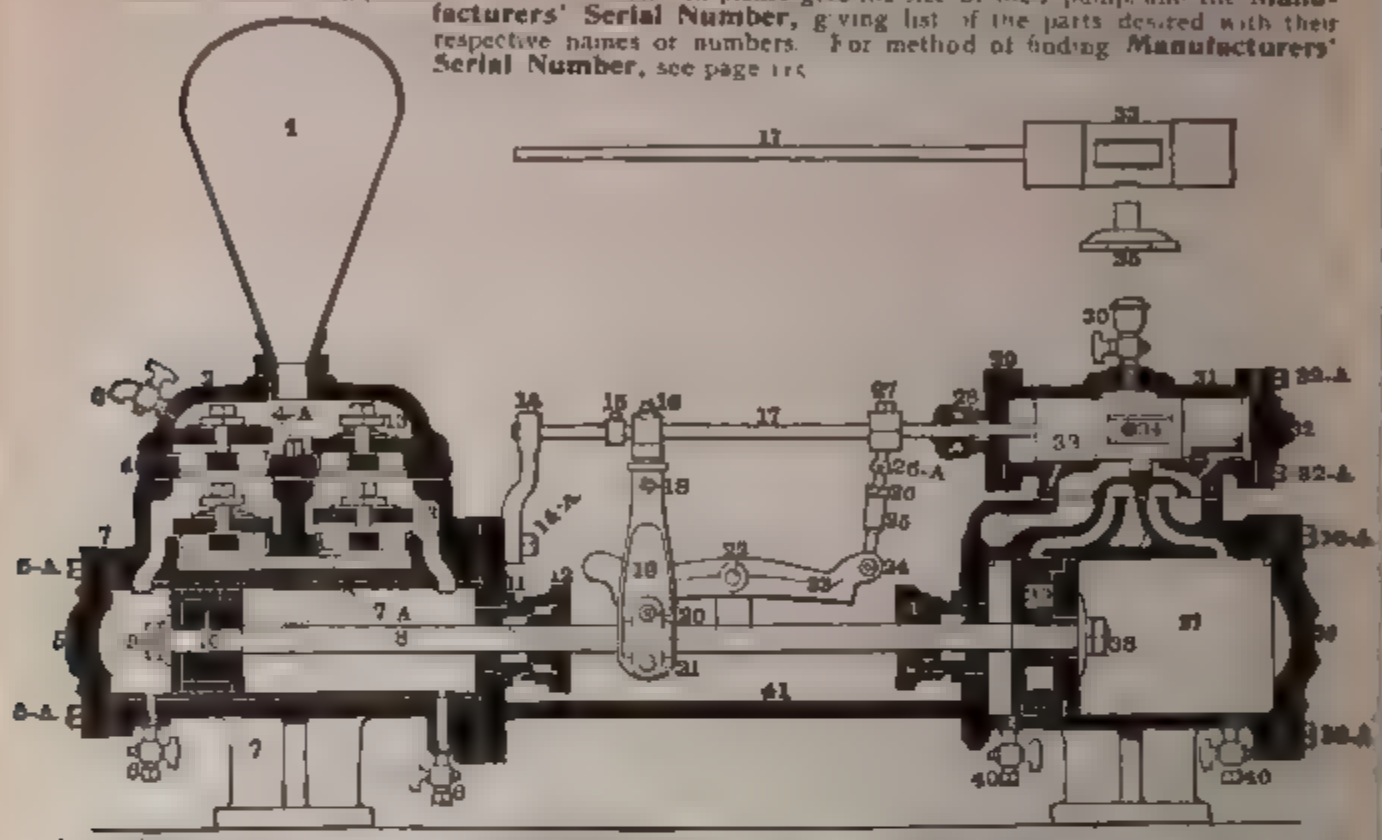
LIST OF PARTS.

100. Ring Bolt.
101. Upper Steam Cylinder Head.
102. Wrought Iron Dog — main piece.
103. " " " — lower piece.
104. Bolt, for lower Wrought Iron Dog.
105. Nut, " " " "
106. Washer, " " " "
107. Bracket for Rocker.
108. Piston Rod.
109. " " Nut.
110. Tie Rod.
111. " " Nut.
112. Water Plunger.
113. " " Stuffing Box Gland.
114. " " " " Pack'g.
115. " " " " Bolt.
116. " " " " Nut.
117. Main Stuffing Box Casting.
118. Upper Water Cylinder Casting.
119. Lower " " "
120. Bolts for fastening Dogs to Pumps.
121. Swing Bolts with nuts and washers, for fastening upper water cyl. casting to lower water cyl. casting.
122. Hinge Pin for Lug Bolt.
123. " " " Swing-off Holding Bolt.
124. Swing-off Holding Bolt, Nut and Washer.
125. Removable Cylinder.
126. Discharge Valve.
127. " " Spring.
128. " " Bolt.
129. " " Nut.
130 Pump Bucket, forming seat of discharge valve.
131. Suction Valve.
132. " " Seat.
133. " " Spring.
134. " " Bolt.
135. Valve Rod Guide.
136. Piston Rod Stuffing Box Gland (for steam cylinder).
137. Steam Chest.
138. Rocker Bar.
139. Tappet Arm.

For other parts of Pump (for Steam Cylinder, Valve Gear, etc.), see next page.

PARTS OF KNOWLES SINGLE PUMPS—REGULAR PATTERN.

Customers in ordering parts, to avoid mistakes, will please give the size of their pump, and the **Manufacturers' Serial Number,** giving list of the parts desired with their respective names or numbers. For method of finding **Manufacturers' Serial Number,** see page 115.



1 Air Chamber
2 Water Cap
2A Water Cap Swing Bolt, complete, with Nut, Washer and Pin. (Not shown in cut.)
3 Air Cock
4 Valve [illegible] False Seat
4A Valve Plate Bolt
5 Water Cylinder Head
5A Water Cylinder Head Bolt
6 Drip Cocks for Water Cylinder
7 Water Cylinder or Working Barrel including Lining and Suction Valve Seats, but no other parts.
7A Brass Lining for Water Cylinder or Working Barrel.
8 Piston Rod complete, with Nuts and Lock Nuts for both ends
9 Piston Rod Nut and Lock Nut Water End
10 Water Piston Canvas packed complete, [illegible] Head, Follower, [illegible] Segments and Packing
10A Water Piston Head
10B Water [illegible]
10C Water [illegible] Follower Bolts [illegible]
10D Water Piston Packing [illegible]
10E Water Piston Set Screws per set [illegible]
11 [illegible] Stuffing Box complete [illegible]
11A Piston [illegible] Seat
11B [illegible] Stuffing Box [illegible]
12 [illegible]
12 [illegible]
13A Rubber Valve, "Soft," for cold water.
13B Rubber Valve "Hard" for hot water.
13C Rubber Valve Seat
13D Rubber Valve Stem.
13E Rubber Valve Spring
13F Metal "Disk" Valve, complete with Seat, Spring and Nut
13G Hinge Valve complete with Seat
13H Ball Valve complete with Seat
13I Cage Valve complete, with Seat, Spring and Nut
13J Cage Valve Drops each
(Not shown in cut.)
14 Valve Rod Cylinder
14A Valve Rod Cylinder Bolt
15 Valve Rod Collar including Set Screw and Nut
15A Valve Rod Collar Set Screw
15B Valve Rod Collar [illegible]
16 Tappet Arm Tip
17 Valve Rod
18 Tappet Tip Set Screw
19 Tappet Arm complete, with Tip, Tip Set Screw and Lower Bolt and Nut
20 Rocker Rod
20A Rocker Rod Stud and Nut
21 Tappet Arm Lower Bolt and Nut
22 Rocker Bar Bolt and Nut
22A Rocker Bar Bolt Set Screw not shown
23 Rocker Bar
24 Rocker Connection Bolt and Nut
25 Rocker Connection
26 Rocker Connection Set Nut
26A Ball [illegible] Nut
27 Valve Rod Clamp [illegible] Bolts and [illegible]
27A Valve Rod Clamp Bolts each
27B Valve Rod Clamp
28 Valve Rod Stuffing Box Nut or Gland
28A Valve Rod Stuffing Box Follower
29 Back Steam Chest Head which combines the Seat for Valve Rod Stuffing Box
30 Lubricator
31 Steam Chest complete includes Heads, with their Bolts, Chest Piston and its Guide Pin, Valve Rod and its Stuffing Box complete, Valve Rod Clamp, Bolts, and [illegible] Valve Rod Collar Set Screw and Gibb, Tappet Arm Tip, Main Slide Valve Ball Joint and Nut
31A Steam Chest without any parts
31B Steam Chest Holding Down Bolts, each not shown
32 Front Steam Chest Head
32A Front Steam Chest Head Bolts (same for back head)
33 Chest Piston
34 Steam Chest Pin
35 Main Slide Valve
36 Steam Cylinder Head,
36A Steam Cylinder Head Bolts
37 Steam Cylinder without any parts
38 Piston Rod Nut and Lock Nut Steam End
39 Steam Piston complete [illegible] Head, Follower, Follower Bolts, Packing Rings, Studs and Springs
39A Steam Piston Head
39B Steam Piston Packing Ring
39C Steam Piston Follower
39D Steam Piston Follower Bolts each
39E Steam Piston Packing Studs per set
39F Steam Piston Packing Springs
40 Steam Cylinder Cocks
*41 Center [illegible] casting between Steam and Water Cylinders

* Pumps [illegible] have both Steam and Water Cylinders made in one casting. No. 3, No. 4 and No. 4½ Pumps have Steam Cylinder and center piece in one casting. [illegible] Pumps, the center piece is a separate casting from both Steam or Water Cylinders.

[redacted]

TO CORRESPONDENTS.

IN ORDERING A PUMP, it is to the interest of the purchaser to fully inform us on the following questions:

1st. For what purpose is the pump to be used? What is the average steam pressure?

2d. What is the liquid to be pumped; and is it hot or cold, clear or gritty, fresh, salt, alkaline, or acidulous?

3d. What is the maximum quantity to be pumped per minute or hour?

4th. To what height is the liquid to be lifted by suction; and what is the length and diameter of the suction pipe, and the number of elbows or bends?

5th. To what height is the liquid to be pumped, and what is the length and size of discharge pipe?

WHEN ORDERING PARTS.

OWING to the fact of our having constructed pumps of the same size for different duties, and also on account of the improvements which we have made from time to time, during our long business career, it is ABSOLUTELY NECESSARY that all orders for parts should be accompanied with the MANUFACTURER'S SERIAL NUMBER of the pump for which said parts are required.

This number will be found stamped in some conspicuous position on every pump made by us. All direct-acting pumps, both single and duplex, have the number stamped on the edge of the *steam cylinder head*. All single pumps have it stamped on the edge of the *steam chest head*, in addition. In the case of the triplex power pumps, there is a number plate which is always placed on the frame, and the SERIAL NUMBER is also stamped on the end of the crank shaft. On single and duplex power pumps, horizontal pattern, the number is always stamped on the crank pin and on the connecting rod strap; also on the outside flange of the water cylinder head. There is also a number plate placed generally on the frame, although sometimes it is placed on the water cylinder on the inside end. On air compressors the number is stamped on the edge of the flange of the cylinder, also on the edge of the cylinder head; and there is also a number plate placed on the centre piece.

As we manufacture every part to gauge, and have a complete record of all pumps built by us, we can send correct duplicate pieces on receipt of above information. Without manufacturer's number we CANNOT duplicate parts with certainty.

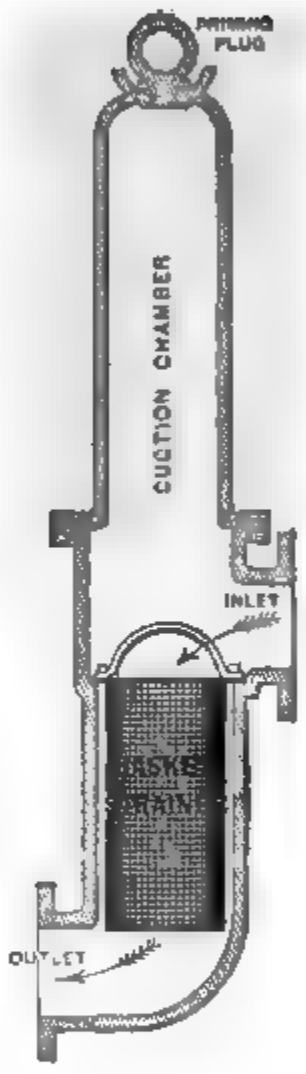
If the MANUFACTURER'S SERIAL NUMBER has become covered with rust, dirt or paint, take a file or a piece of emery cloth and rub at the point indicated above. This will bring out the MANUFACTURER'S NUMBER so that it can be easily read.

KNOWLES STEAM PUMP WORKS.

The Knowles "Side Pipe and Strainer"

With and Without Suction Chamber Attached.

IT IS always very desirable to place an efficient strainer on the suction pipe of a pump where there is any suspicion that the water contains dirt or sediment We recommend the Knowles "side pipe and strainer," with or without suction chamber attached, as shown by engraving, which should always be placed close to the pump The strainer basket inside can be readily taken out and cleaned This arrangement is a great improvement on the method commonly practiced in putting strainers on the end of the suction pipe, where it is more or less inconvenient to get at to clean or repair Should it be necessary to charge the pump with water, as is often the case with long suction pipes, the priming plug shown at top of suction chamber can be easily removed. For plain strainers, see next page



Sizes.

Size of Suction Pipe . . . Inches	2	2½	3	3½	4	5	6	8	10	12
Code Word, with Suction Chamber	a	b	c	d	e	f	g	h	i	j
Code Word, without Suction Chamber	k	l	m	n	o	p	q	r	s	t

a. Entwist
b. Envassal
c. Envenom
d. Enviable
e. Envied
f. Envious
g. Environ
h. Envoy
i. Envying
j. Enwheel
k. Eocene
l. Eolian
m. Eolipile
n. Epanodos
o. Eparch
p. Epaulet
q. Epenetic
r. Epergne
s. Ephemera
t. Ephod

For Plain Suction Strainers, etc., see next page.

Check Valves and Foot Valves.

These valves are made with flanged ends, as shown, or with screwed ends, at same price. When de[sired], they can be made with bell and spigot ends at a slight additional cost.

Fig 1

Fig 2

	Inches	2	2½	3	3½	4	5	6	8	10	12	14	16	18	20
Check Valve Fig 1 Code Word		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Foot Valve Fig 2, Code Word		15	16	17	18	19	20	21	22	23	24	25	26	27	28

STRAINERS.

Fig 3

Fig 4

Fig 5

Inches	2	2½	3	3½	4	5	6	8	10	12	14
Strainer Fig 3, Code Word	29	30	31	32	33	34	35	36	37	38	39
Strainer, Fig 4, Code Word	40	41	42	43	44	45	46	47	48	49	50
Strainer and Foot Valve, combined, Fig 5, Code Word	51	52	53	54	55	56	57	58	59	60	61

Epacris	19	Epilepsy	22	Epistle	34	Epulose	42	Equipage
Epaule	20	Epilogue	23	Epitaph	33	Epulotic	43	Equipped
Epaulet	24	Epiphany	24	Epithet	34	Equable	44	Equitant
Epaulette	25	Epiphora	25	Epitome	35	Equant	45	Equity
Epauliere	26	Epiphyte	26	Epitrite	36	Equation	46	Equivoke
Epaulette	27	Epiploce	27	Epitrope	37	Equator	47	Erasable
Epaulet	28	Epiploon	28	Epizoan	38	Equerry	48	Erase
Epergne	29	Epipode	29	Epoch	39	Equiform	49	Erasing
Epergne	30	Epipodic	30	Epode	40	Equine	50	Erasion
Epergne	31	Epiperm	31	Epulary	41	Equinox	51	Erasure
Epergraph								

Equipage	52	Erbium	55	Erinus	58	Ermine	61	Erminys
Equipped	53	Erelius	56	Eremite	59	Ermolin		
Equitant	54	Eremite	57	Eremite	60	Ermine		
Equity	55	Eremite	58	Ergot	61	Erminys		
Equivoke	56	Eremite	59	Ergotism				
Erasable	57	Ergot	60	Eridanus				
Erase	58	Ergotism	61	Erinus				
Erasing	59	Eridanus						
Erasion	60	Erinus						
Erasure	61	Erinnys						

DIRECTIONS FOR SETTING UP AND OPERATING KNOWLES PUMPS.

IN erecting a pump, always be sure that pump is so connected as to provide a full and uniform supply of the liquid to be handled. To accomplish this result, the suction pipe should never be any smaller than the size corresponding to the suction opening of the pump, as per table in the catalogue. When long suction pipes are used, it is necessary to increase the diameter to allow for the increased friction. The suction pipe should, accordingly, always be made as short as possible, and with as few bends as practicable, and, when convenient, use full round bends rather than elbows.

The same remarks apply to the arrangement of the discharge pipe, although not with the same force, since in the discharge pipe the full power of the pump is always available to force the liquid through the discharge piping, while in the case of the suction pipe only the atmospheric pressure is available to force the liquid into the pump.

Care should be taken in laying the suction pipe to maintain a uniform grade, so as to avoid air pockets. Where the water supply is taken from a pond, it is well to lay the suction pipe below the level of the water in the pond, if possible, all the way to the pump, and then to carry the pipe up vertically directly to the pump. In this way, most of the suction pipe will always remain full of water, and liability to air leakage is prevented. Where pipe has to be laid underground, we recommend the use of cast iron flanged pipe for all sizes where it can be obtained. Use every precaution in laying pipe to prevent foreign matter, as sand or iron chips, from entering the pipe. Material of this character will quickly cut out the lining, pistons, and valves of a pump, producing serious injury. The same remarks apply to the steam pipe of the pump.

The suction pipe and its connections must be perfectly air tight, as a very small leak will prevent the proper working of the pump and impair its efficiency. Before covering the suction pipe it is advisable to submit this pipe to a test pressure of about 25 lbs. per square inch, to make sure that no leaks exist.

All valves in the suction and discharge piping should be gate valves.

In all cases where pump is to lift water by suction it will be found convenient to provide a priming pipe leading to the cylinders of the pump, or if suction pipe is provided with a foot valve, this priming pipe may be led to the suction box of the pump. This priming pipe may take its supply from a tank, or from the discharge pipe of the pump; being connected to the discharge pipe at a point beyond the main discharge valve. An air cock is provided for the water cylinder cap, and by opening this air cock the water is allowed to fill the cylinders, displacing the air which they contain.

In admitting water to the suction box of the pump care should be taken that sufficient pressure is not developed at that point to burst any portion of the suction piping. A relief valve placed in the suction pipe will prevent any possibility of this occurring.

When the water cylinders of the pump have been filled with water, the valve in the priming pipe, and the air cock, may be closed, and the pump is then ready for starting.

In the case of light suction lifts the pump will readily pick up the water in the suction pipe without the above precautions being taken.

Pumps of piston pattern, owing to the facility with which packing can be renewed, and the smaller clearance spaces in the pump cylinders, are particularly efficient for lifting water by suction, where the circumstances are such that it is impossible to prime the suction piping before starting the pump.

A large suction chamber placed on the suction pipe close by the pump is very advantageous, and for pumps running at high speed is a necessity.

Care should be taken to locate the suction chamber in the continuation of the line of flow in the suction pipe, so as to relieve the pulsations in the suction pipe in the most efficient manner.

For strainers, foot valves, etc., see pages 116 and 117 of this catalogue.

Water at a high temperature cannot be raised any considerable distance by suction. For pumping very hot water place the supply high enough (or the pump low enough) so that the water will gravitate to the pump.

In connecting the steam pipe make due allowance for the expansion of the steam pipe when heated by the steam.

A throttle valve should be placed in the steam pipe as close to the pump as possible. Means should be provided for draining this pipe before starting the pump.

We recommend placing a small feed water heater in the exhaust pipe from pump; or a three-way cock may be placed in the exhaust piping and the exhaust piping connected to the suction pipe of the pump. After the pump has made a few strokes, exhausting into the atmosphere, this three-way cock may be turned and the exhaust conducted to suction, where it will be entirely condensed on coming into contact with the water flowing to the pump. See suction condenser for sinking pumps, page 33-D. In this way practically the whole of the heat used in supplying steam to operate the pump can be recovered.

Drip plugs are provided in the water end for draining the pump so as to prevent freezing.

Foundations suitable for the pump should always be provided. For a small pump an ordinary wooden floor is sufficient, but for a larger pump a small brick pier resting on the ground and provided with a cap stone is desirable.

If pump is to be stopped to be left idle for some time, fill the oil cup with oil, then open the cock from the oil cup so that this oil can flow into the steam chest; then let the pump make half a dozen quick strokes to distribute the oil well over the inside of the steam end of the pump, and so prevent danger of rusting while the pump is standing.

Keep the stuffing-boxes well packed with a good quality of packing. Don't screw the glands too tight, and don't allow the same packing to remain in the stuffing-boxes long enough to become hard and scratch the piston rod.

For boiler feeding we recommend running the pump at not more than from 30 to 40 strokes per minute when the boiler is evaporating its normal rating (30 lbs. of water per H. P. per hour).

USEFUL INFORMATION.

STEAM.

A CUBIC inch of water evaporated under ordinary atmospheric pressure is converted into a cubic foot of steam (approximately).

The specific gravity of steam (at atmospheric pressure) is .421 that of air at 32° Fahrenheit, and .0006 that of water at same temperature.

27,222 cubic feet of steam weigh 1 pound. 13,817 cubic feet of air weigh 1 pound.

Locomotives average a consumption of 3000 gallons of water per 100 miles run.

The best designed boilers, well set, with good draft, and skillful firing, will evaporate from 7 to 10 lbs. of water per pound of first class coal.

In calculating horse power of Tubular or Flue boilers, consider 15 square feet of heating surface equivalent to one *nominal* horse-power.

On one square foot of grate can be burned on an average from 10 to 12 lbs. of hard coal, or 18 to 20 lbs. soft coal, per hour, with natural draft. With forced draft nearly double this amount can be burned.

Steam Engines, in economy, vary from 14 to 60 lbs. of feed water and from 1⅓ to 7 lbs. of coal per hour per indicated H P. See table below for duty of high grade engines.

Condensing engines require from 20 to 30 gallons of water, at an average low temperature, to condense the steam represented by every gallon of water evaporated in the boilers supplying engines—approximately for most engines, we say, from 1 to 1½ galls condensing water per minute per indicated Horse Power.

Surface Condensers should have about 2 square feet of tube (cooling) surface per horse-power for a compound steam engine. Ordinary Engines will require more surface according to their economy in the use of steam It is absolutely necessary to place air pumps below condensers to get satisfactory results.

RATIO OF VACUUM TO TEMPERATURE (FAHRENHEIT) OF FEED WATER.

00 inches, Vacuum	212°	22½ inches, Vacuum	150°	28½ inches, Vacuum	[illegible]
21 " "	190°	*25 " "	135°	29 " "	[illegible]
18 " "	170°	27½ " "	112°	29½ " "	[illegible]

* Usually considered the standard point of efficiency—Condenser and Air Pump being well proportioned.

WEIGHT AND COMPARATIVE FUEL VALUE OF WOOD.

1 Cord Air-dried Hickory or Hard Maple weighs about 4500 lbs., and is equal to about 2000 lbs. coal.
1 " " White Oak weighs about 3850 lbs., and is equal to about 1715 lbs. coal.
1 " " Beech, Red Oak or Black Oak, weighs about 3250 lbs., and is equal to about 1450 lbs. coal.
1 " " Poplar (whitewood), Chestnut or Elm, weighs about 2350 lbs., and is equal to about 1050 lbs. coal.
1 " Average Pine, weighs about 2000 lbs., and is equal to about 925 lbs. coal.

From the above it is safe to assume that 2¼ lbs. of dry wood is equal to 1 lb. average quality of soft coal, and that the fuel value of the same *weight* of different woods is very nearly the same—that is, a pound of hickory is worth no more for fuel than a pound of pine, assuming both to be dry It is important that the wood be dry, as each 10 per cent of water or moisture in wood will detract about 12 per cent from its value as fuel.

DUTY OF STEAM ENGINES.

A well-known engineer of high authority gives the following comparative figures showing the economy of high grade steam engines in actual practice.

Type of Engine.	Temperature of Feed Water.	Lbs. of Water Evaporated per lb. of Combined Coal.	Pounds of Steam per I. H. P. used per hour.	Pounds of Combined Coal used per I. H. P. per hour.	Cost per I. H. P. per hour, supplying Coal at $5.00 per ton.
Non-Condensing,	212°	10 5	29.	2 75	$0 0073
Condensing	100°	9 4	20	2 17	0 0056
Compound Jacketed	100°	9.4	17.	1 81	0.0045
Triple Expansion Jacketed	100°	9 4	13 6	1 44	0.0036

*** The effect of a good condenser and air pump should be to make [illegible] about 2-[illegible] effective pressure, with the same terminal pressure, or to give the same mean pressure [illegible] correspondingly less terminal pressure When the load on the engine requires about half the work at 30 lbs., one-third of the work at 40 lbs., one-fourth, a *practically* the condenser will save from one-fourth to one-third of the fuel, *cut-off or throttling*, where a sufficient supply of water is available. See [illegible] *and description of Knowles* Improved Air Pump and Condenser.

USEFUL INFORMATION - WATER.

Doubling the diameter of a pipe increases its capacity four times. Friction of liquids in pipes increases as the square of the velocity. See table of "Friction of Water in Pipes," on page 102.

The mean pressure of the atmosphere is usually estimated at 14.7 lbs. per square inch, so that with a perfect vacuum it will sustain a column of mercury 29.9 inches or a column of water 33.9 feet high, at sea level.

To find the pressure in pounds per square inch of a column of water, multiply the height of the column in feet by .434. Approximately, we say that every foot elevation is equal to ½ lb. pressure per square inch, this allows for ordinary friction.

To find the diameter of a pump cylinder to move a given quantity of water per minute (100 feet of piston being the standard of speed), divide the number of gallons by 4, then extract the square root, and the product will be the diameter in inches of the pump cylinder.

To find quantity of water elevated in one minute running at 100 feet of piston speed per minute. Square the diameter of the water cylinder in inches and multiply by 4. Example: Capacity of a 5-inch cylinder is desired. The square of the diameter (5 inches) is 25, which, multiplied by 4, gives 100, the number of gallons per minute (approximately).

***To find the horse power* necessary to elevate water to a given height, multiply the weight of the water elevated per minute in lbs. by the height in feet, and divide the product by 33,000 (an allowance should be added for water friction, and a further allowance for loss in steam cylinder, say from 20 to 30 per cent.)**

The area of the Steam Piston, multiplied by the steam pressure, gives the total amount of pressure that can be exerted. *The area of the water piston*, multiplied by the pressure of water per square inch, gives the resistance. A *margin* must be made between the *power* and the *resistance* to *move* the pistons at the required speed—say from 20 to 40 per cent, according to speed and other conditions.

To find the capacity of a cylinder in gallons. Multiplying the area in inches by the length of stroke in inches will give the total number of cubic inches; divide this amount by 231 (which is the cubical contents of a U. S. gallon in inches), and product is the capacity in gallons.

WEIGHT AND CAPACITY OF DIFFERENT STANDARD GALLONS OF WATER.

	Cubic Inches in a Gallon.	Weight of a Gallon in pounds.	Gallons in a Cubic Foot.	Weight of a cubic foot of water, English standard, 62.321 lbs. Avoirdupois.
Imperial or English.....	277.274	10.00	6.232102	
United States	231.	8.33111	7.480519	

Weight of Crude Petroleum, 6½ lbs. per U. S. gallon, } 42 gallons to the barrel.
Weight of Refined " 6⅝ lbs. per U. S. gallon, }

A "miner's inch" of water is approximately equal to a supply of 12 U. S. gallons per minute.

FIRE STREAMS.

Pressures required at nozzle and at pump, with quantity and pressure of water necessary to throw water various distances through different sized nozzles—using 2½ inch rubber hose and smooth nozzles.

G. A. Ellis, C.E.

Size of Nozzles.	1 Inch.				1⅛ Inch.				1¼ Inch.				1¼ Inch.			
Pressure at Nozzle	40	60	80	100	40	60	80	100	40	60	80	100	40	60	80	100
*Pressure at Pump or hydrant with 100 ft. 2½-in. rubber hose	48	73	97	121	54	81	108	135	61	92	123	154	71	107	144	180
Gallons per minute	155	189	219	245	196	240	277	310	242	297	342	383	293	368	413	462
Horizontal distance thrown	109	42	268	286	13	148	175	191	118	156	186	207	124	166	200	224
Vertical dist. thrown	72	98	131	48	82	112	137	157	82	115	142	164	85	128	146	169

* For greater lengths of 2½ hose the increased friction can readily be obtained by noting the differences between the above given "pressure at nozzle" and "pressure at pump or hydrant with 100 feet of hose." For instance, if it requires at hydrant or pump 8 lbs. more pressure than it does at nozzle to overcome the friction when pumping through 100 feet of 2½ inch hose (using 1 inch nozzle, with 40 lb. pressure at said nozzle), then it requires 16 lbs. pressure to overcome the friction in forcing through 200 feet of same size hose.

FRICTION OF WATER IN PIPES.

Friction-loss in Pounds Pressure per square inch, for each 100 feet of length in different size clean Iron Pipe discharging given quantities of water per minute. G. A. Ellis, C.E.

Gals. per minute	SIZES OF PIPES—INSIDE DIAMETER.															
	¾ In.	1 In.	1¼ In.	1½ In.	2 In.	2½ In.	3 In.	4 In.	6 In.	8 In.	10 In.	12 In.	14 In.	16 In.	18 In.
5	3.3	0.84	0.31	0.12											
10	13.0	3.16	1.05	0.47	0.12										
15	28.7	6.98	2.38	0.97											
20	50.4	12.3	4.07	1.66	0.42										
25	78.0	19.0	6.40	2.62		0.21	0.10	.027							
30		27.5	9.15	3.75	0.91										
35		37.0	12.4	5.05											
40		48.0	16.1	6.52	1.60		.20								
45			20.2	8.15											
50			24.9	10.0	2.44	0.81	0.35	0.09							
75			56.1	22.4	5.32	1.80	0.74	0.23							
100				39.0	9.46	3.20	1.31	0.33	0.05						
125					14.9	4.89	1.99								
150					21.2	7.0	2.85	0.69	0.10						
175					28.1	9.46	3.85								
200					37.5	12.47	5.02	1.22	0.17						
250						19.66	7.76	1.89	0.26	0.07	0.03	0.01			
300						28.06	11.2	2.66	0.37	0.09	0.04				
350							15.2	3.65	0.50	0.12	0.05	0.02			
400							19.5	4.73	0.65	0.16	0.06				
450							25.0	6.01	0.81	0.20	0.07	0.03			
500							30.8	7.43	0.96	0.25	0.09	0.04	0.17	0.089	0.05
750									2.21	0.53	0.18	0.08			
1000									3.88	0.94	0.32	0.13	0.062	0.036	0.020
1250										1.46	0.49	0.20			
1500										2.09	0.70	0.29	0.135	0.071	0.40
1750											0.95	0.38			
2000											1.23	0.49	0.234	0.123	0.071
2250												0.63			
2500												0.77	0.362	0.188	0.107
3000												1.11	0.515	0.267	0.150
3500													0.697	0.365	0.204
4000													0.910	0.472	0.26
4500														0.593	0.333
5000														0.730	0.413

AREAS OF CIRCLES.

Diam.	Area.	Diam.	Area.	Diam.	Area.	Diam.	Area.	Diam.	Area.	Diam.	Area.	Diam.	Area.
⅛	.012	4 in.	12.56	13 in.	132.73	22 in.	380.13	31 in.	754.7	40 in.	1256.6	49 in.	1885.4
¼	.049	⅛	15.90	⅛	143.13	½	397.60	½	779.3	½	1288.2	½	1924.4
⅜	.10	5 in.	19.63	14 in.	153.94	23 in.	415.47	32 in.	804.2	41 in.	1320.2	50 in.	1963.5
½	.196	¼	23.75	¼	165.13	⅛	433.73	½	829.5	½	1352.6	½	2002.9
⅝	.441	6 in.	28.27	15 in.	176.71	24 in.	452.39	33 in.	855.3	42 in.	1385.4	51 in.	2042.3
1 in.	.785	⅛	33.18	⅜	188.69	¼	471.43	½	881.41	½	1418.6	½	2083.5
⅛	.994	7 in.	38.48	16 in.	201.06	25 in.	490.8	34 in.	907.9	43 in.	1452.2	52 in.	2123.7
¼	1.227	¼	44.17	⅛	213.82	⅛	510.7	½	934.8	½	1486.1	½	2164.4
⅜	1.767	8 in.	50.26	17 in.	226.98	26 in.	530.9	35 in.	962.1	44 in.	1520.5	53 in.	2206.2
½	2.405	⅛	56.74	¼	240.52	⅛	551.5	½	989.8	¼	1555.2	½	2248.8
⅝	3.141	¼	63.61	18 in.	254.46	27 in.	572.5	36 in.	1017.8	45 in.	1590.4	54 in.	2290.2
¾	3.976	⅜	70.88	⅜	268.80	½	593.9	½	1046.3	½	1625.9	½	2332.8
⅞	4.908	10 in.	78.54	19 in.	283.53	28 in.	615.7	37 in.	1075.2	46 in.	1661.9	½	2375.8
1	5.939	⅛	86.59	½	298.64	½	637.9	½	1104.4	½	1698.2	½	2419.2
1 in.	7.06	11 in.	95.03	20 in.	314.16	29 in.	660.5	38 in.	1134.1	47 in.	1734.9	55 in.	2463.0
⅛	8.29	⅛	1.87	½	340.06	½	683.4	½	1164.1	½	1772.2	½	2507.8
¼	9.62	12 in.	113.10	21 in.	346.36	30 in.	706.8	½	1194.6	48 in.	1808.6	56 in.	2552.7
⅜	11.04	2	122.71	½	363.5	½	730.6	½	1225.4	½	1847.4	½	2598.7

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GENERAL TELEGRAPHIC CODE.

ABC CODE, AI CODE, OR LIEBER'S CODE ALSO USED.

Cable Address—"Dogmatic," New York.

GENERAL CORRESPONDENCE.

Replying to your telegram of to-day.	Webenest. Full particulars will be sent by mail.
Replying to your telegram of yesterday.	Weberbaum. Answer by mail.
Replying to your telegram of day before yesterday.	Weberkarde. Answer by telegraph.
Referring to your order No. _ _	Weberlade. Will write you fully to-day.
Referring to your letter of ____	Weberlied. Will write you fully in a day or two.
Referring to your letter No. _ _	Weberlohn. Please give us weight of heaviest piece (or weight of heaviest piece is).
Referring to our order No. __	Webersmann. Please give us size of largest piece (or size of largest piece is).
Referring to our letter of _ _	Webervogel. Telegraph what pump you recommend as best fitted to the following conditions of service —
Referring to our letter No. _____	Weberzange. What H. P. boiler is necessary to run pump under the stated conditions?
The manufacturers' serial number of the pump is (read the next word as a numeral in the AI code).	Webestoff. _ _ H. P. boiler is necessary to run pump under the stated conditions.
The manufacturers' serial number of the pump is.	Webewerk. When will you be at —
What is the manufacturers' serial number of the pump?	Webster. When will you leave?
State steam pressure.	Websterite. What will be your next address?
State water pressure.	Webstuhl. What do you advise?
State capacity required in U. S. gallons per minute.	Wechselrad. Send blue print by first mail.
State capacity required in U. S. gallons per twenty-four hours.	Weckendes. Send blue print for order by first mail.
This represents the maximum service that will be required of the pump; the ordinary service is considerably less severe.	Weckeruhr. As per Knowles general catalogue, edition of 1895, page
Is pump to be simple, compound, triple expansion, condensing, non-condensing, or power driven?	Weckruf. As per Knowles catalogue of electrically operated power pumps, page
What is the maximum temperature of injection water?	Wedded. As per Knowles catalogue of paper-makers' power pumps, page
Cannot fulfill conditions named with pump of size specified. Would recommend the following —	Wedderij. As per Knowles catalogue of mining pumps, page
	Weddings. As per Knowles catalogue of air pumps and condensers, page _ _
	Wedel. As per Blake general catalogue, page

PRICES AND QUOTATIONS.

Telegraph price of —	Weekheid Telegraph size and price of pump to perform the following service -
Telegraph price and weight of —	Weeklacht. Prices quoted are net.
Telegraph price and weight of _ _ __and how soon you can ship.	Weekloon. Prices quoted are subject to the usual discount.
Telegraph price of ____and how soon you can ship.	Weekmarkt. Prices quoted are subject to per cent. discount.
Telegraph price of pump to perform the following service, and confirm quotation by mail with full particulars.	Weeksteen. Price is for pump alone with no extras.
Telegraph size, price, weight, and time in which you can deliver a pump to perform the following service —	Weeldebron. Price includes all fittings and fixtures called for in specification.
Send us by mail size, price, weight, and time in which you can deliver a pump to perform the following service —	Weeldehof. Price is net for delivery f. o. b. cars at factory.
Telegraph price, weight, and time in which you can deliver a pump to perform the following service —	Weelderig. Price is net, and includes boxing for export and delivering f. o. b. steamer at New York.
Telegraph price and weight of pump to perform the following service —	Weemoed. Price is net, and includes boxing for export and delivering f. o. b. steamer at Boston.
	Weemoedig. Our only terms are cash on presentation of bill of lading.
	Weenend. Our only terms are cash with order.

ORDERING.

Weevilled.	Enter our order for the following and ship to us here immediately.
Weftage.	Enter our order for the following and ship to us at_ ....
Wegaetzen.	Enter our order for the following and ship to_____at_____
Weganlage.	Enter our order for the following and hold for shipping instructions.
Wegbannen.	Duplicate order No.____ .
Wegbegeben.	Duplicate order No.__ ..twice.
Wegbeizen.	Duplicate order No._____three times.
Wegbikken.	Ship as early as possible one pump as per our order____
Wegblazen.	Ship as early as possible two pumps as per our order_____
Wegblicken.	Please add the following to our order____
Wegbuigen.	Ship us at once following parts as per page____of Knowles general catalogue.
Wegdooien.	Ship us at once following parts as per page____of Blake general catalogue.
Wegdruipen.	Order will be canceled if not shipped within time specified.
Wegdweilen.	Cancel our order.
Wegeamt.	Too late to cancel order.
Wegeamtes.	Accept order on conditions named.
Wegebau.	We cannot accept the order on the conditions specified.
Wegedistel.	Suspend work on order_____till you receive further instructions.
Wegedoorn.	Have entered your order and will ship __
Wegelerche.	Order_____ is now ready and will leave by first steamer.
Wegelos.	Order. ___ has been detained in consequence of defect being discovered.
Wegeloser.	Order_____is ready for shipment, but we cannot secure freight room on steamer about leaving. Will ship by first opportunity.
Wegemesser.	The order is urgent, give it special attention.

TIME OF DELIVERY.

Weggesnapt.	Delivery in one day after receipt of order.
Weggesneld.	Delivery in two days after receipt of order.
Weggetrapt.	Delivery in three days after receipt of order.
Weggevijld.	Delivery in four days after receipt of order.
Weggewaaid.	Delivery in five days after receipt of order.
Weggezakt.	Delivery in six days after receipt of order.
Weggezeld	Delivery in seven days after receipt of order.
Weggezet.	Delivery in eight days after receipt of order.
Weggleiten.	Delivery in nine days after receipt of order.
Weghakken.	Delivery in ten days after receipt of order.
Weghinken.	Delivery in eleven days after receipt of order.
Weghoebest.	Delivery in twelve days after receipt of order.
Wegholen.	Delivery in one week after receipt of order.
Weghuepfen.	Delivery in two weeks after receipt of order.
Weghuschen.	Delivery in three weeks after receipt of order.
Wegjagen.	Delivery in four weeks after receipt of order.
Wegkapen.	Delivery in five weeks after receipt of order.
Wegkehren.	Delivery in six weeks after receipt of order.
Wegknagen.	Delivery in seven weeks after receipt of order.
Wegknijpen.	Delivery in eight weeks after receipt of order.
Wegkruien.	Delivery in nine weeks after receipt of order.
Wegkwijnen.	Delivery in ten weeks after receipt of order.
Weglachen.	Delivery in one month after receipt of order.
Weglagern.	Delivery in two months after receipt of order.
Weglating.	Delivery in three months after receipt of order.
Weglaufen.	Delivery in four months after receipt of order.
Weglehnen.	Delivery in five months after receipt of order.
Weglenken.	Delivery in six months after receipt of order.
Wegleugnen.	Delivery in seven months after receipt of order.
Wegmeter.	Delivery in eight months after receipt of order.
Wegnehmen.	Delivery in nine months after receipt of order.
Wegneming.	Delivery in ten months after receipt of order.
Wegpaschen.	Delivery in eleven months after receipt of order.
Wegpflanze.	Delivery in twelve months after receipt of order.

SHIPPING.

Wegsterben.	Ship by freight.
Wegsteuer.	Ship by fast freight this day without fail.
Wegstossen.	Ship by all-rail route.
Wegstrich.	Ship by express.
Wegstunde.	Ship by express to-day without fail.
Wegtilgen.	Ship by steamer.
Wegtrappen.	Ship by sailing vessel.
Wegvallen.	Ship by cheapest route.
Wegvloeien.	How soon can you ship?
Wegvoeren.	When did you ship?
Wegvreten.	When can you ship our order No.___

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SHIPPING — CONTINUED.

:n.	Your order No._____will be shipped.
	Your order No._____was shipped.
ı.	Was shipped_____on steamer_____
.	Was shipped_____bills of lading were forwarded_____
r.	Have you ready for immediate shipment?
rn.	We have in stock ready for immediate shipment.
a.	Order No.____must be shipped by____
.	Order No._____will be canceled unless shipped by_____
nen.	Order will be canceled if not shipped within time specified.
l.	Give our order_____special attention, and telegraph us when you will ship. Hurry this. Important.
Wehlaut.	Ship and draw with bill of lading attached.
Wehmuethig.	By what route did you ship?
Wehrbinde.	Telegraph car number.
Wehrloser.	Shall we ship all rail?
Wehrmann.	If you cannot ship at once, telegraph us.
Wehrthurm.	Send tracer immediately after shipment of_____
Wehruf.	Unable to ship, as promised, pump on your order_____Will forward. ____
Wehrzoll.	We expect to ship.
Wehthat.	Telegraph shipping instructions for your order_____
Wehvoll.	Prepay freight.

TYPES OF PUMPS.

.	Pump to be of the vertical type.
ım.	Pump to be of the horizontal type.
ın.	Pump to be of piston pattern.
.z.	Pump to be of the removable cylinder pattern.
!.	Pump to be of the inside plunger pattern.
rb.	Pump to be of the double plunger pattern (outside packed plungers).
ıe.	Pump to be of the solid cylinder outside plunger pattern, with valve caps bolted on.
ıt.	Pump to be of the pot valve outside packed plunger pattern.
	Pump to be of the central packed outside plunger pattern.
t.	Pump to be of the single type.
	Pump to be of the single compound type.
le	Pump to be of the single triple compound condensing type.
.	Special duplex pump.
l.	Pump to be of the duplex type.
	Pump to be of the compound duplex type.
ı.	Pump to be of the compound, duplex type, with low pressure cylinders located between high pressure cylinders and water cylinders.
er.	Pump to be of the compound, duplex type, with high pressure cylinders located between low pressure cylinders and water cylinders.
ıle.	Pump to be of the triple compound duplex condensing type.
:e.	Pump to be compound duplex condensing.
	Pump to be compound duplex non-condensing.
l.	Pump to be of the fly-wheel type.
	Pump and boiler combined.
	Pump and boiler mounted on wheels.
b.	Vertical duplex pump.
	Vertical simplex boiler feed pump.
;.	Vertical simplex light service pump.
Weighable.	Automatic feed pump and receiver with receiver placed alongside of pump.
Weighting.	Automatic feed pump and receiver, with the receiver placed above the pump.
Weighty.	Single power pump, belted, no gears.
Weigrond.	Single power pump, belted, with gears.
Weihaltar.	Pump to be of the duplex belted type, without intermediate gears.
Weihbecken.	Pump to be of the duplex belted type, with intermediate gears connecting pulley shaft to crank shaft.
Weihéa.	Pump to be of the duplex power driven type, fitted with gear and pinion, and with pinion shaft extended ready to receive coupling, but without any pulley.
Weihebrot.	Pump to be of the horizontal, triplex, belted type.
Weihekranz.	Pump to be of the horizontal triplex type, arranged with extended bed plate to receive motor, including all gearing.
Weihelied.	Pump to be of the vertical, triplex, belted type.
Weihenfuss.	Pump to be of the vertical, triplex type, arranged with extended bed plate to receive motor, including all gearing.
Weihetafel.	Pump to be arranged for driving by belt, and no gears to be furnished.
Weihetanz.	Direct acting blowing engine.
Weihevoll.	Single fly-wheel air compressor.
Weihgesang.	Duplex fly-wheel air compressor.
Weihlicht.	Belt driven single air compressor.
Weikaas.	Belt driven duplex air compressor.
Weilanden.	Sinking pump, bucket and plunger pattern.
Weinapfel.	Sinking pump, central packed outside plunger pattern.
Weinart.	Sinking pump, Palmer type, two steam cylinders tandem.
Weinbalsam.	Horizontal air pump and jet condenser.
Weinbann.	Combined air and circulating pump.
Weinbecher.	Combined air and boiler feed pump.
Weinbeere.	Marine air pump, horizontal pattern.

TYPES OF PUMPS — CONTINUED.

Weinbergen. Vertical double acting marine air pump.
Weinblume. Horizontal circulating or wrecking pump.
Weinfarbe. Vertical wrecking pump.
Weinfleck. Vertical irrigating pump.
Weinfreund. Vacuum pump.
Weinfrohne. Fly-wheel vacuum pump, single type.
Weingalle. Duplex fly-wheel vacuum pump.
Weingegend Combined vacuum and water pump.
Weingehalt. Duplex hydraulic pump.
Weingeruch. Single hydraulic pump.
Weinguelte Low pressure pump.
Weinhahn. Pump to be of the vertical beam pattern, with one steam cylinder, and two single acting pump cylinders.
Weinhandel. Pump to be of the vertical twin pattern, with two steam cylinders, and with two single acting pump cylinders.
Weinhitze. Pump to be of the vertical twin pattern, with two steam cylinders, and with two double acting pump cylinders.
Weinhoehe. Pump to be of the vertical twin combined air and circulating type, with single acting air cylinder and double acting circulating cylinder, and two steam cylinders.
Weinholz. Pump to be of the vertical, twin, combined air and circulating type, with two steam cylinders, and both pump cylinders single acting.
Weinhuelse. Pump to be of the vertical, beam, combined air and circulating type, with one steam cylinder, and both pump cylinders single acting.
Weinigje. Pump to be of the vertical, beam, combined air and circulating type, with single acting air cylinder, and double acting circulating cylinder, and one steam cylinder.
Weinkanne. Pump to be of the vertical, twin, combined air and circulating type, with two steam cylinders, and with both pump cylinders double acting.
Weinkeller. Pump to be of the vertical, beam, combined air and circulating type, with one steam cylinder, and with both pump cylinders double acting.
Weinknecht. Pump to be of the vertical, tandem, combined air and circulating type, all cylinders double acting.
Weinkneipe. Pump to be of the horizontal, cross-compound, fly-wheel type.
Weinkopf. Pump to be of the horizontal, triple expansion, fly-wheel type, one high pressure cylinder on one side, one intermediate pressure cylinder on the opposite side, and two low pressure cylinders, one on each side.
Weinkoster. Pump to be of the vertical, compound, fly-wheel type, with single acting water plungers.
Weinkrampf. Pump to be of the vertical, compound, fly-wheel type, with double acting water plungers.
Weinlaub. Pump to be of the vertical, triple expansion, fly-wheel type, with single acting water plungers.
Weinlauben. Pump to be of the vertical, triple expansion, fly-wheel type, with double acting water plungers.
Weinlieder. Pump to be of the differential plunger type.
Weinmakler. Pump to be of the bucket and plunger type.
Weinmarkt. Pump to be same style as shown in Knowles photograph No. ——
Weinmeth. Pump to be same style as shown in Blake photograph No. ——
Weinmonat. Pump to be same style as shown on Knowles drawing No. ——
Weinmuster. Pump to be same style as shown on Blake drawing No. ——
Weinmuthig. Pump to be *exactly* as shown on Knowles drawing No. ——
Weinnachen. Pump to be *exactly* as shown on Blake drawing No. ——

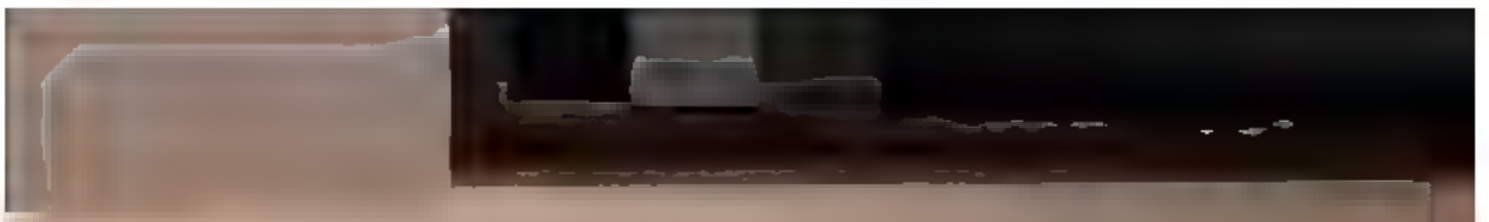
SPECIFICATIONS.

Weissarmig. Water is clear.
Weissbalg. Water is gritty.
Weissbirke. Water is acidulous.
Weissbrot. Pump is for fresh water.
Weissbuche. Pump is for salt water.
Weissdorn. Pump is to handle water at a temperature below 120 degrees Fahr.
Weisserzen. Pump is to handle water at a temperature above 120 degrees Fahr.
Weissfuchs. Pump to handle oil.
Weissgelb. Pump to be provided with—
Weissglanz. Pump to have hard rubber valves.
Weisshafer. Pump to have soft rubber valves.
Weissite. Pump to have brass valves.
Weisskraut. Pump to be provided with ball valves of composition.
Weisskunig. Pump to be provided with ball valves of hard rubber.
Weissling. Pump to be provided with mechanically moved valves in pump end.
Weissmehl. *Pump to have brass ring packing in pump piston.*
Weissmoewe. Pump to have brass ring packing in pump piston and brass valves.
Weissroth. Pump to have brass piston rods.
Weisssauer. Pump to have brass plungers.
Weissstein. Pump to have brass glands.
Weisssud. Pump to have brass lined stuffing-boxes.
Weisstanne. Pump to be brass fitted.
Weissweine. Pump to be brass fitted and to have brass valves.
Weisswurz. Pump to be provided with brass valve plates.
Weisung. Pump to have pump end made entirely of composition metal.
Weisungen. Pump to be all iron fitted—no brass parts.
Weitab. Pump to be provided with hand power attachment.
Weitachsig. Pump to be provided with metallic packing for stuffing-boxes of steam end.
Weitaestig. Nickel-plated sight feed lubricator to be furnished.
Weitasch. Pump to have iron air chamber.

[redacted]

SPECIFICATIONS — CONTINUED.

tans.	Pump to have copper air chamber.
tblick.	Suction air chamber to be furnished.
tblumig.	No suction air chamber included.
tfaltig.	Pump to have attached boiler feed pump.
tgehend.	Pump to be provided with speed governor.
theruig.	No speed governor to be included.
tnetz.	Pump to be provided with pressure governor.
tsicht.	No pressure governor to be included.
tsinn.	Speed of motor to be_____ revolutions per minute.
tspurig.	Pump to have low pressure steam cylinders steam jacketed.
tum.	Pump to have all steam cylinders steam jacketed.
tzinkig.	To have air cylinders water jacketed.
vat.	Steam and water ends to be connected by tie rods.
zenbau.	Steam and water ends to be connected by cast-iron centre piece.
zenbrot.	Pump to be provided with the Knowles valve motion.
zenfeld.	Pump to be provided with the Blake valve motion.
zenjahr.	Pump to be provided with the simplex valve motion.
zenkorn.	Pump to be provided with the standard duplex valve motion with adjustable collars on valve rods.
zenland.	Pump to be provided with valve motion of the same type as used on "special duplex" pumps.
zenrost.	Pump to be provided with all the extras shown in photograph.
zensaat.	Pump to be provided with all the extras shown on drawing.
zenteig.	Special fittings shown in the photograph not to be furnished.
zelijks.	Special fittings shown on drawing not to be furnished.
ztari.	Automatic water pressure relief valve set at_ ____lbs. pressure.
laway.	Plain strainer like figure 3, page 117 of this catalogue.
lbegaafd.	Basket strainer like figure 4, page 117 of this catalogue.
lbehagen.	Strainer and foot valve combined like figure 5, page 117 of this catalogue.
lbeklant.	Side pipe and strainer.
lbemand.	Check valve.
lbereid.	Foot valve.
lbevolkt.	Gate valve.
lbewerkt.	Steam throttle valve.
lbezocht.	Steam end of pump to be provided with Russia iron lagging covering steam cylinder barrels.
lche.	Steam end of pump to be provided with wood strip lagging on the steam cylinder barrels.
lcherie.	Steam end of pump to be provided with cabinet wood lagging covering entire steam end.
lcome.	Pipe openings threaded for English standard pipe thread.
lcomely.	Pipe openings threaded for U. S. standard pipe thread.
Welcoming.	Flanges to be drilled.
Weldénies.	Flanges to be left undrilled.
Weldoen.	All openings to be flanged.
Weldoeners.	Companion flanges to be furnished.
Weldra.	Length of stroke to be (or is)—
Welfare.	Pump to have water cylinders_ inches diameter.
Welfenthum.	Revolutions per minute.
Welfisches.	Feet piston speed per minute.
Welgaan.	Steam end alone.
Welgeaard.	Pump end alone.
Welgeboren.	Suction lift is_____feet.
Welgelegen.	Diameter of suction pipe is ___inches.
Welgemeend.	Length of suction pipe is ___feet.
Welgemoed.	Diameter of discharge pipe is _ inches.
Welgesteld.	Length of discharge pipe is_ _ feet.
Welgevormd.	Low pressure steam pistons to have two piston rods each.
Welgezind.	Low pressure steam pistons to have one piston rod each.
Welgrond.	To be arranged with open suction, suction valves opening direct to atmosphere.
Welhaast.	To be arranged with confined suction valves.
Weliger.	To have poppet valves in air cylinder heads.
Weligheid.	To have radial air valves.
Welkend.	Pump to have_____feet of intermediate connections complete between steam and water cylinders.
Welkender.	Pump to be provided with . feet of wood sucker rods, no pipe to be furnished.
Welkheit.	Pump to be provided with . feet of wood sucker rods and the same length of wrought-iron piping.
Welkomst.	Pump to be provided with feet of wood sucker rods and the same length of flush joint piping.
Welladay.	Pump to be provided with jet condenser of the cone type.
Wellbeing.	Pump to be provided with jet condenser of the spray type.
Wellenberg.	Vacuum pump is for dry system.
Wellenbild.	Vacuum pump is for wet system.
Wellengrab.	Diameter of exhaust inlet to be —
Wellenhorn.	Diameter of injection pipe to be—
Wellenkamm.	Pump to have buckets of composition.
Wellentanz.	Pump to have bucket rods of composition.
Wellenthal.	Pump to have head valves on composition plates.
Wellenvoll.	Pump to have buckets and bucket rods of composition and to be provided with head valves on composition plates.
Wellenzug.	Pump to be provided with head valves on iron plates.
Wellevend.	Pump to be provided with air pump and jet condenser complete.
Wellness.	Pump to be provided with air pump and surface condenser complete.
Wellring.	Condensing apparatus not included.
Welluidend.	Horizontal automatic exhaust relief valve with flanges drilled as per catalogue.
Wellustig.	Horizontal automatic exhaust relief valve with flanges left undrilled.
Welnemen.	Vertical automatic exhaust relief valve with flanges drilled as per catalogue.



TYPES OF PUMPS — CONTINUED.

Weinbergen	Vertical double acting marine air pump
Weinblume	Horizontal circulating or wrecking pump
Weinfarbe	Vertical wrecking pump
Weinfleck	Vertical irrigating pump
Weinfreund	Vacuum pump
Weinfrohne	Fly-wheel vacuum pump, single type
Weingalle	Duplex fly wheel vacuum pump
Weingegend	Combined vacuum and water pump
Weingehalt	Duplex hydraulic pump
Weingeruch	Single hydraulic pump
Weinguelte	Low pressure pump
Weinhahn	Pump to be of the vertical beam pattern with one steam cylinder and two single acting pump cylinders
Weinhandel	Pump to be of the vertical twin pattern with two steam cylinders, and with two single acting pump cylinders
Weinhitze	Pump to be of the vertical twin pattern with two steam cylinders and with two double acting pump cylinders
Weinhoehe	Pump to be of the vertical twin combined air and circulating type with single acting air cylinder and double acting circulating cylinder, and two steam cylinders
Weinholz	Pump to be of the vertical, twin, combined air and circulating type, with two steam cylinders and both pump cylinders single acting
Weinhuelse	Pump to be of the vertical, beam, combined air and circulating type with one steam cylinder, and both pump cylinders single acting
Weinigle	Pump to be of the vertical beam combined air and circulating type, with single acting air cylinder, and double acting circulating cylinder and one steam cylinder
Weinkanne	Pump to be of the vertical, twin, combined air and circulating type with two steam cylinders, and with both pump cylinders double acting
Weinkeller	Pump to be of the vertical beam combined air and circulating type with one steam cylinder and with both pump cylinders double acting
Weinknecht	Pump to be of the vertical tandem combined air and circulating type all cylinders double acting
Weinkneipe	Pump to be of the horizontal cross compound fly-wheel type
Weinkopf	Pump to be of the horizontal triple expansion fly wheel type one high pressure cylinder on one side one intermediate pressure cylinder on the opposite side and two low pressure cylinders one on each side
Weinkoster	Pump to be of the vertical compound fly wheel type with single acting water plungers
Weinkrampf	Pump to be of the vertical compound fly wheel type with double acting water plungers
Weinlaub	Pump to be of the vertical triple expansion fly wheel type, with single acting water plungers
Weinlauben	Pump to be of the vertical triple expansion fly wheel type, with double acting water plungers
Weinlieder	Pump to be of the differential plunger type
Weinmakler	Pump to be of the bucket and plunger type
Weinmarkt	Pump to be same style as shown in Knowles photograph No
Weinmeth	Pump to be same style as shown in Blake photograph No
Weinmonat	Pump to be same style as shown on Knowles drawing No
Weinmuster	Pump to be same style as shown on Blake drawing No.
Weinmuthig	Pump to be *exactly* as shown on Knowles drawing No
Weinnachen	Pump to be *exactly* as shown on Blake drawing No

SPECIFICATIONS.

Weissaring	Water is clear
Weissbalg	Water is gritty
Weissbirke	Water is acidulous
Weissbrot	Pump is for fresh water
Weissbuche	Pump is for salt water
Weissdorn	Pump is to handle water at a temperature below [illegible] degrees Fahr
Weisserzen	Pump is to handle water at a temperature above [illegible] degrees Fahr
Weissfuchs	Pump to handle oil
Weissgelb	Pump to be provided with
Weissglanz	Pump to have hard rubber valves
Weisshafer	Pump to have soft rubber valves
Weissite	Pump to have brass valves
Weisskraut	Pump to be provided with ball valves of composition
Weisskuing	Pump to be provided with ball valves of hard rubber
Weissling	Pump to be provided with mechanically moved valves in pump end
Weissmehl	Pump to have brass ring packing in pump piston
Weissmoewe	Pump to have brass ring packing in pump piston and brass valves
Weissroth	Pump to have brass piston rods
Weisssauer	Pump to have brass plungers
Weissstein	Pump to have brass glands
Weisssud	Pump to have brass lined stuffing boxes
Weisstanne	Pump to be brass fitted
Weissweine	Pump to be brass fitted and to have brass valves
Weisswurz	Pump to be provided with brass valve plates
Weisung	Pump to have pump end made entirely of composition metal
Weisungen	Pump to be [illegible] fitted [illegible] brass parts
Weitau	Pump to be provided with hand power attachment
Weitachsig	Pump to be provided with metallic packing for stuffing boxes of steam end
Weitaestig	Nickel plated sight feed lubricator to be furnished
Weitasch	Pump to have iron air chamber

[redacted]

CAPACITIES — CONTINUED.

apacity required is	2500	U S gal	per min	Wezelbont,	Capacity required is	4600	U. S. gal.	per min.
" "	2600	"	"	Wezeltjes,	" "	4700	"	"
" "	2700	"	"	Wezelvel,	" "	4800	"	"
" "	2800	"	"	Whalebone,	" "	4900	"	"
" "	2900	"	"	Whaleman,	" "	5000	"	"
" "	3000	"	"	Whaling,	" "	5500	"	"
" "	3100	"	"	Whallabee,	" "	6000	"	"
" "	3200	"	"	Whally,	" "	6500	"	"
" "	3300	"	"	Wharfage,	" "	7000	"	"
" "	3400	"	"	Wharfing,	" "	7500	"	"
" "	3500	"	"	Wharfinger,	" "	8000	"	"
" "	3600	"	"	Whatever,	" "	8500	"	"
" "	3700	"	"	Whatness,	" "	9000	"	"
" "	3800	"	"	Wheat,	" "	10000	"	"
" "	3900	"	"	Wheaten,	" "	11000	"	"
" "	4000	"	"	Wheedled,	" "	12000	"	"
" "	4100	"	"	Wheedling,	" "	13000	"	"
" "	4200	"	"	Wheelage,	" "	14000	"	"
" "	4300	"	"	Wheelless,	" "	15000	"	"
" "	4400	"	"	Wheelman,				
" "	4500	"	"					

STEAM PRESSURES.

Steam pressure is	5	lbs. per	sq. in.	Whipe,	Steam pressure is	120	lbs. per	sq. in.
" "	10	"	"	Whipsters,	" "	125	"	"
" "	15	"	"	Whirlicote,	" "	130	"	"
" "	20	"	"	Whirligig,	" "	135	"	"
" "	25	"	"	Whirlpool,	" "	140	"	"
" "	30	"	"	Whirls,	" "	145	"	"
" "	35	"	"	Whirlwind,	" "	150	"	"
" "	40	"	"	Whirrick,	" "	160	"	"
" "	45	"	"	Whisk,	" "	170	"	"
" "	50	"	"	Whisked,	" "	180	"	"
" "	55	"	"	Whistles,	" "	190	"	"
" "	60	"	"	Whistling,	" "	200	"	"
" "	65	"	"	Whistpel,	" "	210	"	"
" "	70	"	"	Whittisch,	" "	220	"	"
" "	75	"	"	Whiteboy,	" "	230	"	"
" "	80	"	"	Whiteflaw,	" "	240	"	"
" "	85	"	"	Whitening,	" "	250	"	"
" "	90	"	"	Whitesmith,	" "	260	"	"
" "	95	"	"	Whitespur,	" "	270	"	"
" "	100	"	"	Whitestone,	" "	280	"	"
" "	105	"	"	Whitlavies,	" "	290	"	"
" "	110	"	"	Whitleyes,	" "	300	"	"
" "	115	"	"	Whitlow,				

WATER PRESSURES.

Total Water pressure is	5	lbs. per	sq. in	Wickenklee,	Total Water pressure is	90	lbs. per	sq. in.
" "	10	"	"	Wickered,	" "	95	"	"
" "	15	"	"	Wicleñsme,	" "	100	"	"
" "	20	"	"	Wichffite,	" "	110	"	"
" "	25	"	"	Wicopy,	" "	120	"	"
" "	30	"	"	Wicterp,	" "	130	"	"
" "	35	"	"	Widderfell,	" "	140	"	"
" "	40	"	"	Widderhorn,	" "	150	"	"
" "	45	"	"	Widerart,	" "	160	"	"
" "	50	"	"	Widerbaum,	" "	170	"	"
" "	55	"	"	Widerbild,	" "	180	"	"
" "	60	"	"	Widerdruck,	" "	190	"	"
" "	65	"	"	Widerfahrt,	" "	200	"	"
" "	70	"	"	Widerflug,	" "	220	"	"
" "	75	"	"	Widergeist,	" "	240	"	"
" "	80	"	"	Widerglanz,	" "	260	"	"
" "	85	"	"	Widerhorst,	" "	280	"	"

WATER PRESSURES — CONTINUED.

Widerkampf,	Total Water pressure is	300	lbs.	per	sq.	in.
Widerruf,	"	"	320	"	"	"
Widerspan,	"	"	340	"	"	"
Widerwort,	"	"	360	"	"	"
Widgeon,	"	"	380	"	"	"
Widow,	"	"	400	"	"	"
Widowhood,	"	"	420	"	"	"
Widowly,	"	"	440	"	"	"
Widriger,	"	"	460	"	"	"
Wieden,	"	"	480	"	"	"
Wiederrein,	"	"	500	"	"	"
Wieders,	"	"	550	"	"	"
Wiederwahl,	"	"	600	"	"	"
Wiedijzer,	"	"	650	"	"	"
Wiedmes,	"	"	700	"	"	"
Wiedvolk,	"	"	750	"	"	"
Wiegeband,	"	"	800	"	"	"
Wiegebedje,	"	"	850	"	"	"
Wiegekap,	"	"	900	"	"	"
Wiegekleed,	"	"	950	"	"	"
Wiegekoord,	"	"	1000	"	"	"
Wiegelaken,	"	"	1100	"	"	"
Wiegeln,	"	"	1200	"	"	"
Wiegenbett,	"	"	1300	"	"	"
Wiegenkost,	"	"	1400	"	"	"
Wiegenlaut,	"	"	1500	"	"	"
Wiegentuch,	"	"	1600	"	"	"
Wiegepoot,	"	"	17	"	"	"
Wiegetouw,	"	"	1800	"	"	"
Wiegmeisje,	"	"	1900	"	"	"
Wielbanden,	"	"	2000	"	"	"

Wielboom,	Total Water pressure is	2000	lbs.	per	sq.	in.
Wieldert,	"	"	2100	"	"	"
Wieldoorn,	"	"	2200	"	"	"
Wielers,	"	"	2300	"	"	"
Wielewaal,	"	"	2400	"	"	"
Wielstok,	"	"	2500	"	"	"
Wieltrog,	"	"	2600	"	"	"
Wienerkalk,	"	"	2700	"	"	"
Wienerlack,	"	"	2800	"	"	"
Wierdijk,	"	"	2900	"	"	"
Wierookvat,	"	"	3000	"	"	"
Wierplant,	"	"	3100	"	"	"
Wiesengras,	"	"	3200	"	"	"
Wiesenklee,	"	"	3300	"	"	"
Wiesenkohl,	"	"	3400	"	"	"
Wiesenland,	"	"	3500	"	"	"
Wiesenmaus,	"	"	3600	"	"	"
Wiesenraum,	"	"	3700	"	"	"
Wifshood,	"	"	3800	"	"	"
Wigandies,	"	"	3900	"	"	"
Wigdrijver,	"	"	4000	"	"	"
Wiggen,	"	"	4100	"	"	"
Wiggeries,	"	"	4200	"	"	"
Wighers,	"	"	4300	"	"	"
Wigmaker,	"	"	4400	"	"	"
Wigreve,	"	"	4500	"	"	"
Wigstaart,	"	"	4600	"	"	"
Wihtisite,	"	"	4700	"	"	"
Wihtraed,	"	"	4800	"	"	"
Wijbrood,	"	"	4900	"	"	"
Wijdbeens,	"	"	5000	"	"	"

CAPACITIES OF FREE AIR.

Wijnbouw,	Capacity	5	cu.	ft.	of free air	per	min.
Wijnbouwer,	"	10	"	"	"	"	
Wijndruif,	"	15	"	"	"	"	
Wijnfleesch,	"	20	"	"	"	"	
Wijngaard,	"	25	"	"	"	"	
Wijngelag,	"	30	"	"	"	"	
Wijnglazen,	"	35	"	"	"	"	
Wijngod,	"	40	"	"	"	"	
Wijnheuvel,	"	45	"	"	"	"	
Wijnhuis,	"	50	"	"	"	"	
Wijnhuizen,	"	55	"	"	"	"	
Wijnkan,	"	60	"	"	"	"	
Wijnkelder,	"	65	"	"	"	"	
Wijnkelk,	"	70	"	"	"	"	
Wijnkooper,	"	75	"	"	"	"	
Wijnkruik,	"	80	"	"	"	"	
Wijnmaand,	"	85	"	"	"	"	
Wijnmoer,	"	90	"	"	"	"	
Wijnoogst,	"	95	"	"	"	"	
Wijnpacht,	"	100	"	"	"	"	
Wijnpeiler,	"	120	"	"	"	"	
Wijnpers,	"	140	"	"	"	"	
Wijnperzik,	"	160	"	"	"	"	
Wijnpijp,	"	180	"	"	"	"	
Wijnplant,	"	200	"	"	"	"	
Wijnpomp,	"	250	"	"	"	"	
Wijnroemer,	"	300	"	"	"	"	
Wijnsaus,	"	350	"	"	"	"	
Wijnschaal,	"	400	"	"	"	"	
Wijnslang,	"	450	"	"	"	"	
Wijnsmaak,	"	500	"	"	"	"	

Wijnsoep,	Capacity	550	cu.	ft.	of free air	per	min.
Wijnsoort,	"	600	"	"	"	"	
Wijnsteen,	"	650	"	"	"	"	
Wijnsteker,	"	700	"	"	"	"	
Wijnstok,	"	750	"	"	"	"	
Wijntijd,	"	800	"	"	"	"	
Wijnton,	"	850	"	"	"	"	
Wijntros,	"	900	"	"	"	"	
Wijnveld,	"	950	"	"	"	"	
Wijnvlak,	"	1000	"	"	"	"	
Wijnzak,	"	1100	"	"	"	"	
Wijnzakke	"	1200	"	"	"	"	
Wijselijk,	"	1300	"	"	"	"	
Wijsgeer,	"	1400	"	"	"	"	
Wijsgeerig,	"	1500	"	"	"	"	
Wijsheid,	"	1600	"	"	"	"	
Wijsneusig,	"	1700	"	"	"	"	
Wijsvinger,	"	1800	"	"	"	"	
Wijwater,	"	1900	"	"	"	"	
Wijzen,	"	2000	"	"	"	"	
Wijzerbord,	"	2200	"	"	"	"	
Wijzertjes,	"	2400	"	"	"	"	
Wijzigen,	"	2600	"	"	"	"	
Wijziging,	"	2800	"	"	"	"	
Wikgeid,	"	3000	"	"	"	"	
Wildachtig,	"	3500	"	"	"	"	
Wildacker,	"	4000	"	"	"	"	
Wildbach,	"	4500	"	"	"	"	
Wildbachies,	"	5000	"	"	"	"	
Wildbeast,	"	———	"	"	"	"	

(Free air means air measured at the atmospheric pressure.)

CAPACITIES — CONTINUED.

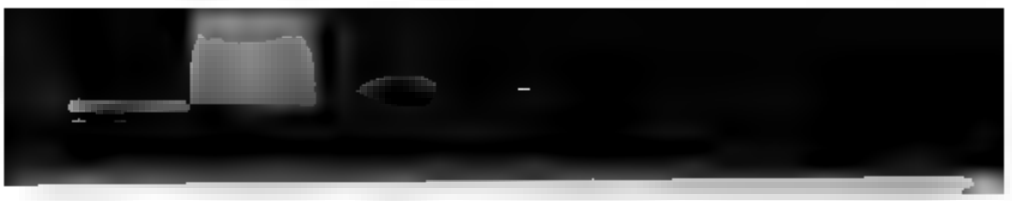
l,	Capacity required is	2500	U. S. gal.	per min.	Weselbont,	Capacity required is	4600	U. S. gal.	per min.
er,	"	2600	"	"	Weseltjes,	"	4700	"	"
n,	"	2700	"	"	Weselvel,	"	4800	"	"
ri,	"	2800	"	"	Whalebone,	"	4900	"	"
nk,	"	2900	"	"	Whaleman,	"	5000	"	"
ld,	"	3000	"	"	Whaling,	"	5500	"	"
ra,	"	3100	"	"	Whallabee,	"	6000	"	"
ch,	"	3200	"	"	Whally,	"	6500	"	"
ct,	"	3300	"	"	Wharfage,	"	7000	"	"
nth,	"	3400	"	"	Wharfing,	"	7500	"	"
ld,	"	3500	"	"	Wharfinger,	"	8000	"	"
ag,	"	3600	"	"	Whatever,	"	8500	"	"
ra,	"	3700	"	"	Whatness,	"	9000	"	"
ig,	"	3800	"	"	Wheat,	"	10000	"	"
en,	"	3900	"	"	Wheaten,	"	11000	"	"
is,	"	4000	"	"	Wheedled,	"	12000	"	"
ver,	"	4100	"	"	Wheedling,	"	13000	"	"
e	"	4200	"	"	Wheelage,	"	14000	"	"
en,	"	4300	"	"	Wheelless,	"	15000	"	"
ham,	"	4400	"	"	Wheelman,	"		"	"
lose,	"	4500	"	"					

STEAM PRESSURES.

pon,	Steam pressure is	5	lbs.	per	sq. in.	Whips,	Steam pressure is	120	lbs.	per	sq. in.
er,	"	10	"	"		Whipsters,	"	125	"	"	
nth,	"	15	"	"		Whirlicote,	"	130	"	"	
	"	20	"	"		Whirligig,	"	135	"	"	
d,	"	25	"	"		Whirlpool,	"	140	"	"	
g,	"	30	"	"		Whirls,	"	145	"	"	
	"	35	"	"		Whirlwind,	"	150	"	"	
h,	"	40	"	"		Whirrick,	"	160	"	"	
ver,	"	45	"	"		Whisk,	"	170	"	"	
d,	"	50	"	"		Whisked,	"	180	"	"	
	"	55	"	"		Whistles,	"	190	"	"	
chy,	"	60	"	"		Whistling,	"	200	"	"	
ry,	"	65	"	"		Whistpel,	"	210	"	"	
rel,	"	70	"	"		Whisttisch,	"	220	"	"	
ng	"	75	"	"		Whiteboy,	"	230	"	"	
er	"	80	"	"		Whiteflaw,	"	240	"	"	
ring,	"	85	"	"		Whitening,	"	250	"	"	
y,	"	90	"	"		Whitesmith,	"	260	"	"	
cal,	"	95	"	"		Whitespur,	"	270	"	"	
l,	"	100	"	"		Whitestone,	"	280	"	"	
gly,	"	105	"	"		Whitlavies,	"	290	"	"	
ed,	"	110	"	"		Whitleyes,	"	300	"	"	
ing,	"	115	"	"		Whitlow,	"		"	"	

WATER PRESSURES.

oever,	Total Water pressure is	5	lbs.	per	sq. in.	Wickenklee,	Total Water pressure is	90	lbs.	per	sq. in.
h,	"	10	"	"		Wickered,	"	95	"	"	
f,	"	15	"	"		Wiclefisme,	"	100	"	"	
,	"	20	"	"		Wicliffite,	"	110	"	"	
d,	"	25	"	"		Wicopy,	"	120	"	"	
se,	"	30	"	"		Wicterp,	"	130	"	"	
ia,	"	35	"	"		Widderfell,	"	140	"	"	
	"	40	"	"		Widderhorn,	"	150	"	"	
se,	"	45	"	"		Widerart,	"	160	"	"	
anz,	"	50	"	"		Widerbaum,	"	170	"	"	
der,	"	55	"	"		Widerbild,	"	180	"	"	
n,	"	60	"	"		Widerdruck,	"	190	"	"	
y,	"	65	"	"		Widerfahrt,	"	200	"	"	
ver,	"	70	"	"		Widerflug,	"	220	"	"	
ras,	"	75	"	"		Widergeist,	"	240	"	"	
land,	"	80	"	"		Widerglanz,	"	260	"	"	
fold,	"	85	"	"		Widerhorst,	"	280	"	"	



WATER PRESSURES — CONTINUED.

Widerkampf,	Total	Water	pressure	is	300	lbs.	per	sq.	in.			
Widerruf,	"	"	"		320	"		"				
Widerspan,	"	"	"		340	"		"				
Widerwort,	"	"	"		360	"		"				
Widgeon,	"	"	"		380	"		"				
Widow,	"	"	"		400	"		"				
Widowhood,	"	"	"		420	"		"				
Widowly,	"	"	"		440	"		"				
Widriger,	"	"	"		460	"		"				
Wieden,	"	"	"		480	"		"				
Wiederreim,	"	"	"		500	"		"				
Wieders,	"	"	"		550	"		"				
Wiederwahl,	"	"	"		600	"		"				
Wiedijzer,	"	"	"		650	"		"				
Wiedmen,	"	"	"		700	"		"				
Wiedvolk,	"	"	"		750	"		"				
Wiegeband,	"	"	"		800	"		"				
Wiegebedje,	"	"	"		850	"		"				
Wiegekap,	"	"	"		900	"		"				
Wiegekleed,	"	"	"		950	"		"				
Wiegekoord,	"	"	"		1000	"		"				
Wiegelaken,	"	"	"		1100	"		"				
Wiegeln,	"	"	"		1200	"		"				
Wiegenbett,	"	"	"		1300	"		"				
Wiegenkost,	"	"	"		1400	"		"				
Wiegenlaut,	"	"	"		1500	"		"				
Wiegentuch,	"	"	"		1600	"		"				
Wiegepoot,	"	"	"		17	"		"				
Wiegetouw,	"	"	"		1800	"		"				
Wiegmeisje,	"	"	"		1900	"		"				
Wielbanden,	"	"	"		2000	"		"				

Wielboom,	Total	Water	pressure	is	2100	lbs.	per	sq.	in.			
Wieldest,	"	"	"		2200	"		"				
Wieldsoms,	"	"	"		2300	"		"				
Wielen,	"	"	"		2400	"		"				
Wielewaal,	"	"	"		2500	"		"				
Wielstok,	"	"	"		2600	"		"				
Wieltros,	"	"	"		2700	"		"				
Wienerkalk,	"	"	"		2800	"		"				
Wienerlack,	"	"	"		2900	"		"				
Wierdlijk,	"	"	"		3000	"		"				
Wierookvat,	"	"	"		3200	"		"				
Wierplant,	"	"	"		3400	"		"				
Wiesengras,	"	"	"		3600	"		"				
Wiesenklee,	"	"	"		3800	"		"				
Wiesenkohl,	"	"	"		4000	"		"				
Wiesenland,	"	"	"		4500	"		"				
Wiesenmaus,	"	"	"		5000	"		"				
Wiesenraum,	"	"	"		5500	"		"				
Wifehood,	"	"	"		6000	"		"				
Wigandies,	"	"	"		7000	"		"				
Wigdrijver,	"	"	"		8000	"		"				
Wiggen,	"	"	"		9000	"		"				
Wiggeries,	"	"	"		10000	"		"				
Wighers,	"	"	"		11000	"		"				
Wigmaker,	"	"	"		12000	"		"				
Wigreve,	"	"	"		13000	"		"				
Wigstaart,	"	"	"		14000	"		"				
Wihtisite,	"	"	"		15000	"		"				
Wihtraed,	"	"	"		16000	"		"				
Wijbrood,	"	"	"		17000	"		"				
Wijdbeens,	"	"	"		18000	"		"				
					19000							
					20000							

CAPACITIES OF FREE AIR.

Wijnbouw,	Capacity	5	cu.	ft.	of	free	air	per	min.			
Wijnbouwer,	"	10	"			"			"			
Wijndruif,	"	15	"			"			"			
Wijnfiesch,	"	20	"			"			"			
Wijngaard,	"	25	"			"			"			
Wijngelag,	"	30	"			"			"			
Wijnglazen,	"	35	"			"			"			
Wijngod,	"	40	"			"			"			
Wijnheuvel,	"	45	"			"			"			
Wijnhuis,	"	50	"			"			"			
Wijnhuizen,	"	55	"			"			"			
Wijnkan,	"	60	"			"			"			
Wijnkelder,	"	65	"			"			"			
Wijnkelk,	"	70	"			"			"			
Wijnkooper,	"	75	"			"			"			
Wijnkruik,	"	80	"			"			"			
Wijnmaand,	"	85	"			"			"			
Wijnmoer,	"	90	"			"			"			
Wijnoogst,	"	95	"			"			"			
Wijnpacht,	"	100	"			"			"			
Wijnpeiler,	"	120	"			"			"			
Wijnpers,	"	140	"			"			"			
Wijnperzik,	"	160	"			"			"			
Wijnpijp,	"	180	"			"			"			
Wijnplant,	"	200	"			"			"			
Wijnpomp,	"	250	"			"			"			
Wijnroemer,	"	300	"			"			"			
Wijnsaus,	"	350	"			"			"			
Wijnschaal,	"	400	"			"			"			
Wijnslang,	"	450	"			"			"			
Wijnsmaak,	"	500	"			"			"			

Wijnsoep,	Capacity	550	cu.	ft.	of	free	air	per	min.			
Wijnsoort,	"	600	"			"			"			
Wijnsteen,	"	650	"			"			"			
Wijnsteker,	"	700	"			"			"			
Wijnstok,	"	750	"			"			"			
Wijntijd,	"	800	"			"			"			
Wijnton,	"	850	"			"			"			
Wijntros,	"	900	"			"			"			
Wijnveld,	"	950	"			"			"			
Wijnvlak,	"	1000	"			"			"			
Wijnzak,	"	1100	"			"			"			
Wijnzakke	"	1200	"			"			"			
Wijselijk,	"	1300	"			"			"			
Wijsgeer,	"	1400	"			"			"			
Wijsgeerig,	"	1500	"			"			"			
Wijsheid,	"	1600	"			"			"			
Wijsneusig,	"	1700	"			"			"			
Wijsvinger,	"	1800	"			"			"			
Wijwater,	"	1900	"			"			"			
Wijzen,	"	2000	"			"			"			
Wijzerbord,	"	2200	"			"			"			
Wijzertjes,	"	2400	"			"			"			
Wijzigen,	"	2600	"			"			"			
Wijziging,	"	2800	"			"			"			
Wikgeld,	"	3000	"			"			"			
Wildachtig,	"	3500	"			"			"			
Wildacker,	"	4000	"			"			"			
Wildbach,	"	4500	"			"			"			
Wildbaches,	"	5000	"			"			"			
Wildbeast,	"											

(Free air means air measured at the atmospheric pressure.)

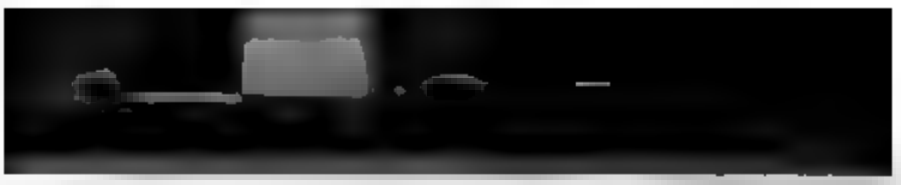
[redacted]

AIR PRESSURES.

Air pressure is	5	lbs. per square inch.	Willekeur,	Air pressure is	170	lbs. per square inch.
"	10	" "	Willenaakt,	"	180	" "
"	15	" "	Willibrord,	"	190	" "
"	20	" "	Willingly,	"	200	" "
"	25	" "	Willknehr,	"	220	" "
"	30	" "	Willowish,	"	240	" "
"	35	" "	Willst,	"	260	" "
"	40	" "	Willums,	"	280	" "
"	45	" "	Wimbling,	"	300	" "
"	50	" "	Wimmeln,	"	350	" "
"	60	" "	Wimmeries,	"	400	" "
"	70	" "	Wimpellijn,	"	450	" "
"	80	" "	Wimpelstok,	"	500	" "
"	90	" "	Wimpeltjes,	"	600	" "
"	100	" "	Wimperhaar,	"	700	" "
"	110	" "	Winchies,	"	800	" "
"	120	" "	Windartig,	"	900	" "
"	130	" "	Windboom,	"	1000	" "
"	140	" "	Windbord,	"	1500	" "
"	150	" "	Windbound,	"	2000	" "
"	160	" "	Windbreker,	"	——	" "

POUNDS OF STEAM PER HOUR.

. . . . .	50	lbs. steam per hour.	Winithar	14000	lbs. steam per hour
. . . . .	100	" "	Winkel	15000	" "
. . . . .	150	" "	Winkelbett	16000	" "
. . . . .	200	" "	Winkelboek	17000	" "
. . . . .	250	" "	Winkeldach	18000	" "
. . . . .	300	" "	Winkeldeur	19000	" "
. . . . .	350	" "	Winkeldoos	20000	" "
. . . . .	400	" "	Winkelgeld	22000	" "
. . . . .	450	" "	Winkelhaak	24000	" "
. . . . .	500	" "	Winkeljagd	26000	" "
. . . . .	600	" "	Winkelknie	28000	" "
. . . . .	700	" "	Winkellade	30000	" "
. . . . .	800	" "	Winkellamp	32000	" "
. . . .	900	" "	Winkelloch	34000	" "
. . . . .	1000	" "	Winkelloge	36000	" "
. . . . .	1100	" "	Winkelluik	38000	" "
. . . . .	1200	" "	Winkelnaad	40000	" "
. . . . .	1300	" "	Winkelraam	42000	" "
. . . . .	1400	" "	Winkeltrap	44000	" "
. . . . .	1500	" "	Winkelwage	46000	" "
. . . . .	1600	" "	Winkelwerk	48000	" "
. . . . .	1700	" "	Winningly	50000	" "
. . . . .	1800	" "	Winnkauf	55000	" "
. . . . .	1900	" "	Winnowed	60000	" "
. . . . .	2000	" "	Winnowing	65000	" "
. . . . .	2500	" "	Winselaffe	70000	" "
. . . . .	3000	" "	Winteranie	75000	" "
. . . . .	3500	" "	Winterbier	80000	" "
. . . . .	4000	" "	Winterdoek	85000	" "
. . . . .	4500	" "	Wintered	90000	" "
. . . . .	5000	" "	Winterfeld	95000	" "
. . . . .	5500	" "	Winterfest	100000	" "
. . . . .	6000	" "	Winterhose	110000	" "
. . . . .	6500	" "	Winterhut	120000	" "
. . . . .	7000	" "	Wintering	130000	" "
. . . . .	7500	" "	Winterjahr	140000	" "
. . . . .	8000	" "	Winterkorn	150000	" "
. . . . .	8500	" "	Winterkuh	160000	" "
. . . . .	9000	" "	Winterlich	170000	" "
. . . . .	10000	" "	Winterluft	180000	" "
. . . . .	11000	" "	Winterly	190000	" "
. . . . .	12000	" "	Wintermaal	200000	" "
. . . . .	13000	" "	Wintermast	——	" "



MAXIMUM TEMPERATURE OF INJECTION WATE

Wintertag,	Maximum	temp.	of	injection	water is	50° F	Winterzon,	Maximum	temp.	of injection
Wintertjes,	"	"	"	"	55°	"	Winthémie,	"	"	"
Wintertuin,	"	"	"	"	60°	"	Wintrous,	"	"	"
Winterzeit,	"	"	"	"	65°	"	Wintry,	"	"	"
Winterzeug,	"	"	"	"	70°	"	Winwaer,	"	"	"

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Introduction

UNLIKE MANY machinery catalogues, the one presented herewith is compiled, not from designs and data of types as yet largely on the draughting board, and with the hope of influencing business by sheer force of novelty and ingenuity, but from knowledge of apparatus already built in our own shops, and thoroughly proven in actual service by customers throughout the world.

The immense variety of machinery in our manufacture enables us to adapt our pumps to the requirements of so many different industries that we are obliged, for the convenience of buyers, to specify the types; and we desire to prevent inconvenience and bewilderment caused by the searching of large catalogues for special apparatus. Therefore, the object of this publication is manifest, namely, to set before the paper manufacturers a catalogue in concise form, intended for their special use.

Our business intercourse with the paper mills has been of so long a duration and so extensive, and we have sought so earnestly the cooperation of superintendents and others employed in the art of paper making, that we are now able to build pumping machinery to fill the requirements exactly.

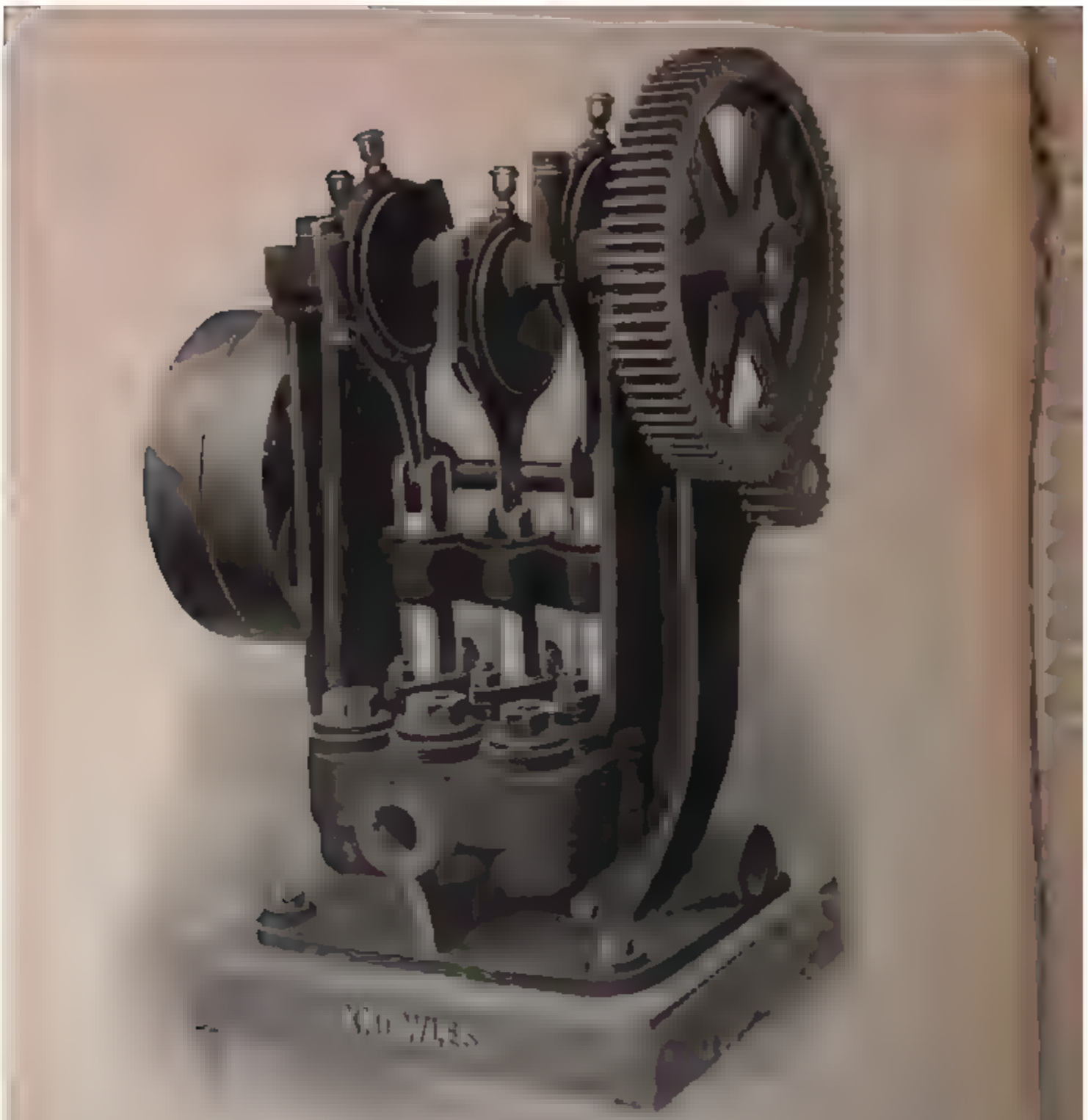
We maintain confidently that our machinery has no equal, on account of the extraordinary attention we have given to details and to workmanship, and the hearty interest we have taken in improvements. Note the success made by our SUCTION BOX VACUUM PUMPS for FOURDRINIER MACHINES. We lay stress also upon the VERTICAL TRIPLEX or THREE-THROW PLUNGER STUFF PUMPS, and the VACUUM PUMPS for SULPHUR FUMES used in the wood-cooking process.

In the following descriptions we have omitted necessarily many points that are interesting, such as prices, weights, the best rules for setting up, and the like. For all such information we invite correspondence. Each customer, on sending us an order, is entitled to receive a blue-print drawing that shows the dimensions, position of foundation bolts, and all connections.

Our Guarantee

Every pump built and sold by us is furnished fully guaranteed; in case of the failure of any of our machines to perform properly the service for which it is warranted, we hold ourselves under obligation to make it fully satisfactory or to refund the price paid.

May, 1898. KNOWLES STEAM PUMP WORKS.



Knowles Vertical Triplex Power Pump—Style D

Size, 3x3

The Knowles Vertical Triplex Power Pump

For Boiler Feeding, etc. Fitted with Valves for Hot or Cold Water or Other Liquids.

THE ILLUSTRATION on opposite page represents the best type of small vertical triplex belt-driven pumps for boiler feed and tank service. The general design is compact and strong, and the arrangement of parts is the best to facilitate *inspection.* The merits of the TRIPLEX or THREE-THROW PATTERN are recognized by all who have used the pumps, because the cranks are set at angles that will bring the plungers continuously upon the water column, without any shock from reversing the stroke; by this means the pumps discharge without pulsation, and the feed to the boiler is steady.

The gears are cut, and run noiselessly; and the plungers are packed from the outside, so any leakage may be readily detected.

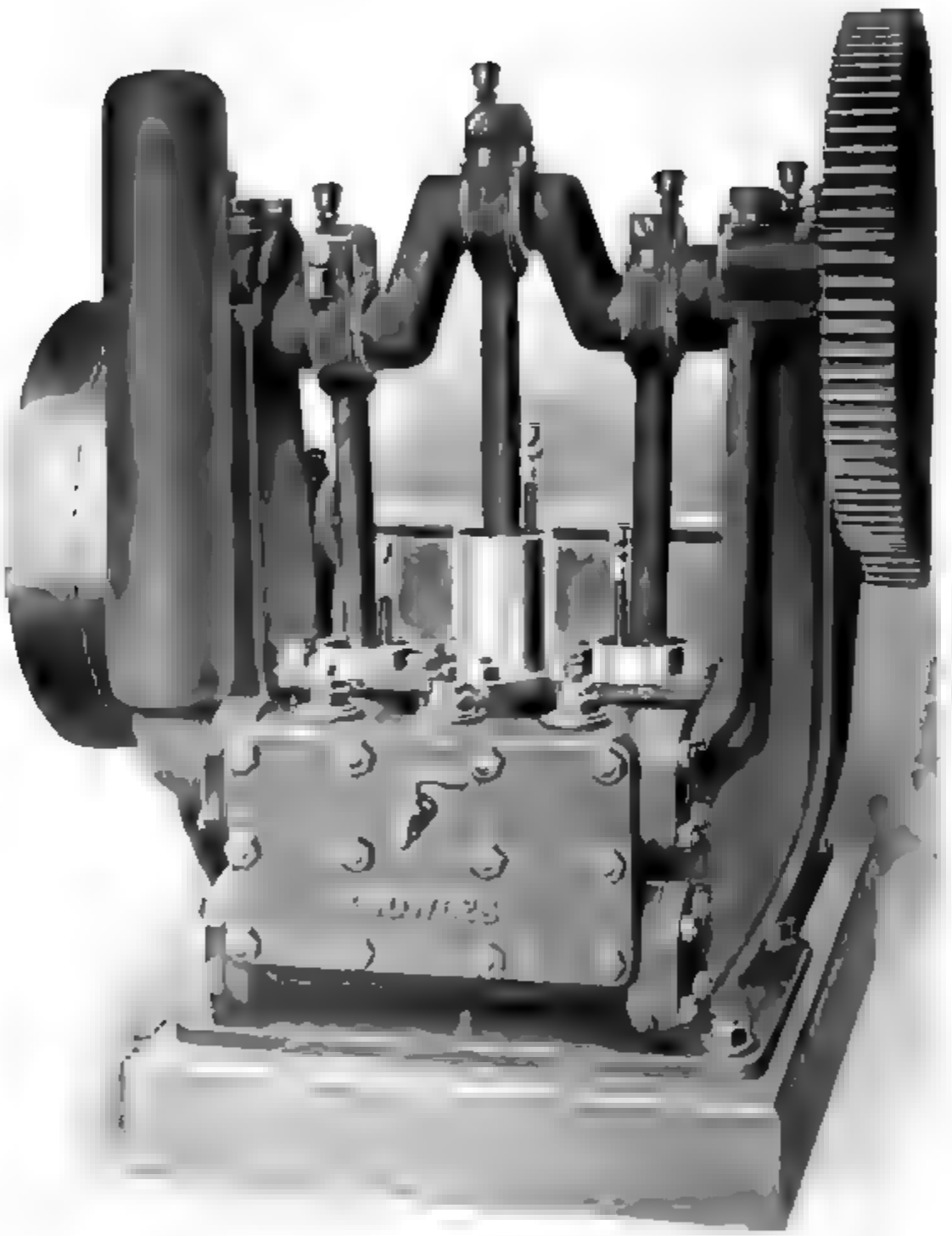
Each pump is provided with *tight and loose pulley, and has suction and discharge openings on opposite sides.* All material is of the highest grade, and great care is taken in the test to prove there is no defect.

All sizes in the following list are suited for 150 pounds water pressure. In sending inquiries or orders, always state the water pressure.

Sizes, Capacities, and Dimensions — Style D.

Diameter of Plungers	Stroke	Revolutions per Minute	Gallons per Revolution	Gallons per Minute	Suction	Discharge	Pulleys Tight and Loose: Diameter	Pulleys Tight and Loose: Face	Ratio of Gears	Dimensions over all: Length	Dimensions over all: Width	Dimensions over all: Height	Code Word
1¼	2	60	.0369	1.914	¾	¾	12	1¼	5 to 1	16⅞	10 13/16	18¼	Dabble
1¾	2½	60	0780	4.680	1	1	12	1¼	5 to 1	19	14½	22½	Dabster
2	3	50	1224	6.120	1¼	1¼	12	2½	5 to 1	23 5/16	16	27	Dado
2½	3	50	.1912	9.560	1½	1½	12	2½	5 to 1	25¼	17¼	28	Daffodil

We have also a full line of patterns for these pumps arranged for operating by electric motors, geared directly to them and mounted on the same bed plate.



Knowles Vertical Triplex Power Pump—Style
Size, 5x6

The Knowles Vertical Triplex Power Pump

For Boiler Feeding. Also for Hydraulic Cylinders of Wood-pulp Grinders. Fitted with Valves for Hot or Cold Water or Other Liquids.

THE GREAT advantage of the triplex form of power pumps over the single or duplex type is fully recognized by the best engineers for all cases in which a steady and continuous discharge is desired, either for producing an even hydraulic pressure, or for preventing water-hammer and unpleasant vibration for elevator or other service in which entire absence of noise is desirable. Even where the adoption of this type is not a necessity for these reasons, its easy running qualities and entire absence of "pound" or jar on piping and foundations recommend its adoption in the majority of cases where final economy is considered, rather than cheapness in first cost.

These pumps are arranged so that either the suction or discharge, or both, may be located on either side of the apparatus — often a point of considerable advantage in crowded locations. While every part is designed to secure the utmost compactness, the valve chambers are arranged so as to allow easy access for inspection or repair. All gears are cut and shaft boxes babbitted. Connecting rods have adjustable brass boxes secured by keys, and the lower ends of connecting rods are held in the plungers by steel pins working in brass bushings in the solid-ends of the rods.

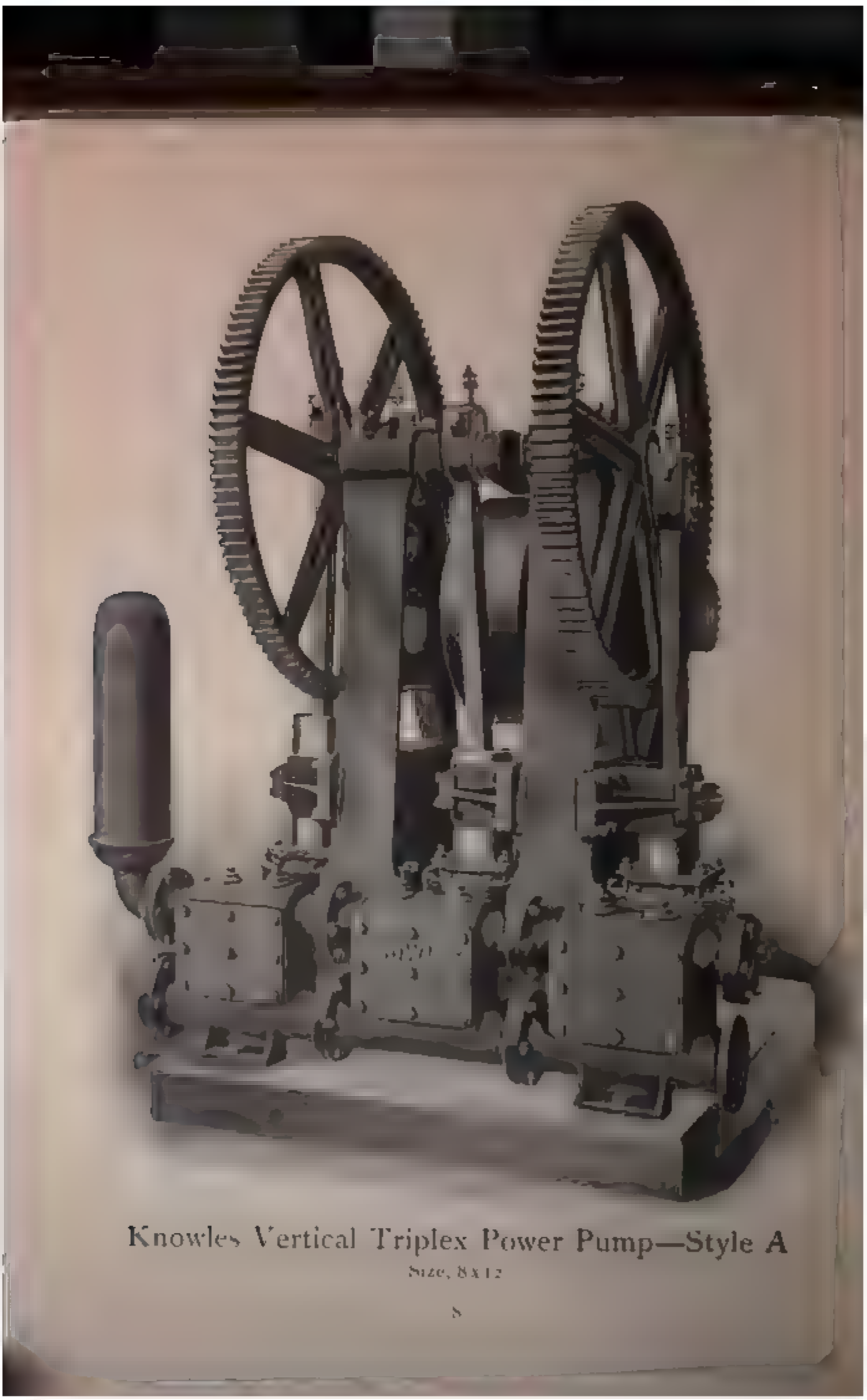
When sending inquiries or orders, give us complete information regarding number of grinders, and size and number of hydraulic cylinders for each grinder; also pressure.

All sizes in the following list are suited for 150 pounds water pressure.

Sizes, Capacities, and Dimensions—Style B.

Diameter of Plungers	Stroke	Revolutions per Minute	Gallons per Revolution	Gallons per Minute	Suction	Discharge	Pulleys, Tight and Loose: Diameter	Pulleys, Tight and Loose: Face	Ratio of Gears	Dimensions over all: Length	Dimensions over all: Width	Dimensions over all: Height	Code Word
2½	4	50	.2500	12.50	1½	1½	15	3	5 to 1	27	17	31	Dagger
3	4	45	.3673	16.53	1½	1½	15	3	5 to 1	32¼	23	29	Dainty
4	4	45	.6528	29.37	2	2	20	3	5 to 1	38¼	28¼	39¼	Dairy
4	6	40	.9787	39.15	2	2	20	3	5 to 1	38¼	28¼	39¼	Dahlia
5	6	40	1.530	61.20	3	3	26	4	5 to 1	40½	35	48½	Dally
5	8	40	2.040	81.60	3	3	30	5	5 to 1	48½	37	48½	Damask
6½	8	40	3.448	137.92	4	4	30	6	5 to 1	62¾	42½	59	Damper
8	8	40	5.222	208.88	5	4	36	6	5 to 1	71	52	62	Damsel
8	10	40	6.525	261.00	5	4	42	6	5 to 1	71	55	63½	Dander

We have also a full line of patterns for these pumps arranged for operating by electric motors, geared directly to them and mounted on the same bed plate.



Knowles Vertical Triplex Power Pump—Style A

Size, 8X12

The Knowles Vertical Triplex Power Pump

For Boiler Feeding. Also for Hydraulic Cylinders of Wood-pulp Grinders. Fitted with Valves for Hot or Cold Water or Other Liquids.

IN COMMON with the ordinary type of triplex pumps, having single acting cylinders and outside packed plungers, this design has the following exclusive features: The plungers are outside packed, guided above, relieving them of excessive wear or strain, and have brass bushed forged steel connecting rods of the locomotive type, with an adjustment at either end for wear. The power is transmitted direct to each of these plungers in the following manner: A countershaft behind the pump transmits the power to spur gears at either end of the pump, driving by crank pins and face plates the two outside plungers, and at the same time through the single throw supporting crank shaft the centre or middle plunger.

This class of pump is also made, when specially ordered, with connecting rods secured to independent crossheads, attached to the upper end of plungers, crossheads being fitted with adjustable shoes in guides.

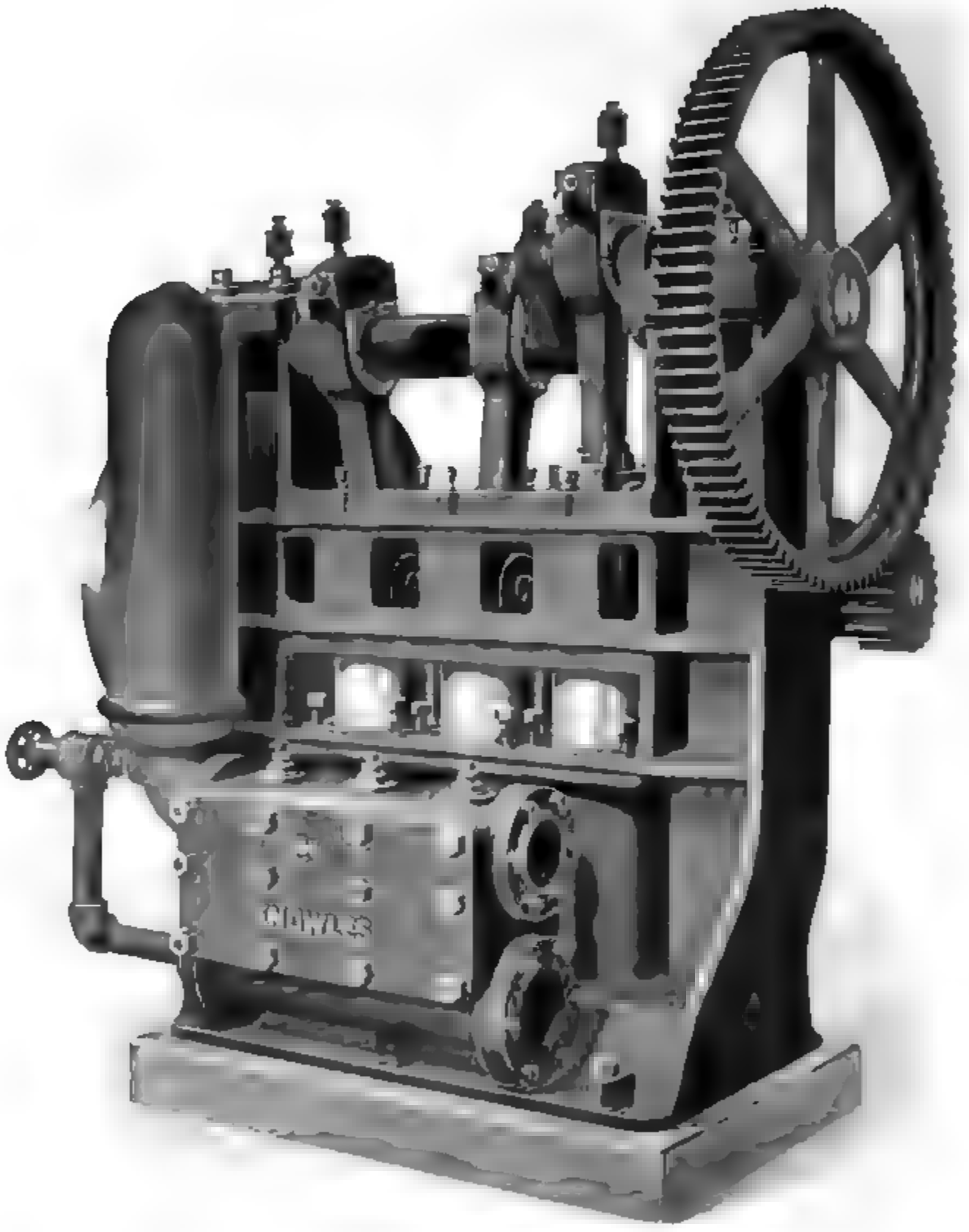
When sending inquiries or orders, give us complete information regarding number of grinders, and size, as well as number, of hydraulic cylinders for each grinder; also pressure.

All sizes in the following list are suited for 150 pounds water pressure.

Sizes, Capacities, and Dimensions — Style A.

Diameter of Plungers	Stroke	Revolutions per Minute	Gallons per Revolution	Gallons per Minute	Suction	Discharge	Pulleys, Tight and Loose		Ratio of Gears	Dimensions over all			Code Word
							Diameter	Face		Length	Width	Height	
8	12	40	7.833	314	5	4	42	6	6 to 1	88	81	105	Dapper
9	10	40	8.262	330	5	4	42	6	6 to 1	88	81	105	Darkly
9	12	40	9.915	397	6	5	42	8	6 to 1	88	81	105	Darling
10	12	40	12.243	490	8	7	42	8	6 to 1	93⅞	81	106½	Dastard
							1 Pulley						
11	12	40	14.811	592	8	7	42	10	6 to 1	93⅞	81	106½	Dauber
12	12	40	17.628	705	10	8	48	10	6 to 1	97½	88	109½	Daunted
13	12	40	20.685	827	10	8	48	12	6 to 1	97½	88	109½	Dazzle

We have also a full line of patterns for these pumps arranged for operating by electric motors, geared directly to them and mounted on the same bed plate.



Knowles Vertical Triplex Power Pump—Style C

Size, 8x8

[redacted]

The Knowles Vertical Triplex Power Pump

For Boiler Feeding. Also for Hydraulic Cylinders of Wood-pulp Grinders. Fitted with Valves for Hot or Cold Water or Other Liquids.

IN WOOD-PULP mills fitted with the most recent apparatus the pulp is forced on the stone grinders by means of hydraulic pressure. It is obvious that this pressure should be steady, as the speed of the shaft and the quality of ground pulp depend directly on steady feeding.

We recommend for such work our triplex pump, as having a continuous discharge, and consequently producing an even pressure upon the pistons of the hydraulic cylinders. This pump, especially constructed for the purpose, is the most efficient machine in the market to-day. Its construction is as shown on opposite page.

We make all sizes in accordance with the number of grinders and diameter of hydraulic cylinders. The pump is suited for pressures up to 150 pounds, and only the best workmanship and material are employed in its construction.

The plungers are packed from outside: the valves can be easily examined, the throat linings replaced when worn, and wearing parts can be taken up.

This pump also has distinctive features rendering it especially suited for boiler feeding and for long, hard service.

The plungers are outside connected, and provided with guides. Connecting rods have phosphor bronze boxes, which are adjustable.

The valves can be fitted for hot or cold water.

We also build boiler feed pumps for high pressure.

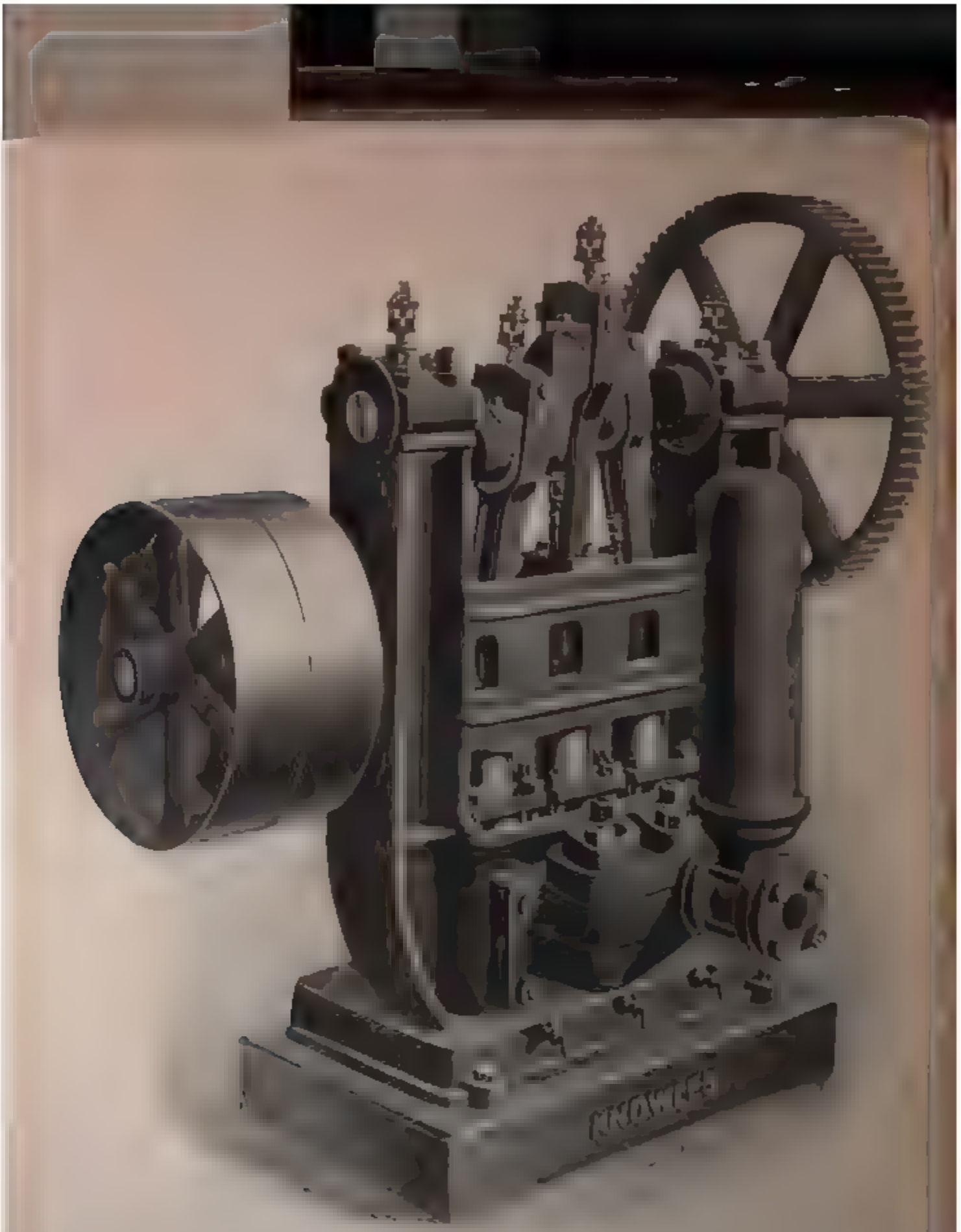
When sending inquiries or orders, give us complete information regarding number of grinders, and number and size of hydraulic cylinders for each grinder; also pressure.

Sizes, Capacities, and Dimensions Style C.

Diameter of Plungers	Stroke	Revolutions per Minute	Gallons per Revolution	Gallons per Minute	Suction	Discharge	Pulleys, Tight and Loose: Diameter	Pulleys, Tight and Loose: Face	Ratio of Gear	Dimensions over all: Length	Dimensions over all: Width	Dimensions over all: Height	Code Word
3	4	45	.3673	16.53	1½	1½	15	3	5 to 1	32¼	23	33½	Fabled
4	4	45	.6528	29.37	2	2	20	3	5 to 1	38¼	28¼	46¼	Fabricate
4	6	40	.9787	39.15	2	2	20	3	5 to 1	38¼	28¼	53	Fabrile
5	6	40	1.530	61.20	3	3	26	4	5 to 1	46	35	54	Fabulist
5	8	40	2.040	81.60	3	3	30	5	5 to 1	48	35	62	Fabulous
6½	8	40	3.448	137.92	4	4	30	6	5 to 1	62¾	43½	71½	Facade
8	8	40	5.222	208.88	5	4	36	6	5 to 1	71⅛	54½	77	Faceless
8	10	40	6.522	261.00	5	4	42	6	5 to 1	71⅛	58	84	Faceted

We have also a full line of patterns for these pumps arranged for operating by electric motors, geared directly to them and mounted on the same bed plate.

NOTE: The run-around pipe and relief valve, shown in cut, will be furnished when requested, at additional price.



Knowles Vertical Triplex Power Pump—Style G

Size 4x6

The Knowles Vertical Triplex Power Pump

For Boiler Feeding. Also for Hydraulic Cylinders of Wood-pulp Grinders.

THE ACCOMPANYING cut shows a type of pump particularly suited for large buildings, where there is but small floor space and where freedom from water hammer is desirable; the three throw arrangement of plungers insuring a uniform and consequently quiet flow of water as well as an unvarying pressure. This machine is good for a pressure of 250 to 300 pounds per square inch There are ample suction and discharge openings on opposite sides of pump cylinder. The valve chambers are of the "pot" type, there being one valve in each compartment, this making a very strong and light construction. Removal of each pot cover gives access to its valve without disturbing any of the other valves.

Plungers are single acting, and guided in generous bearings to insure alignment. Connecting rods have composition adjustable boxes, secured by keys at crank ends: plunger ends of rods are solid, and bushed with removable brass sleeves. Main shaft bearings are lined with hammered babbitt, bored truly to size. Cut gears increase the smoothness of action and life of pump. Tight and loose pulleys are furnished, pulley shaft being supported at both ends in babbitt lined boxes. This machine is wholly self contained.

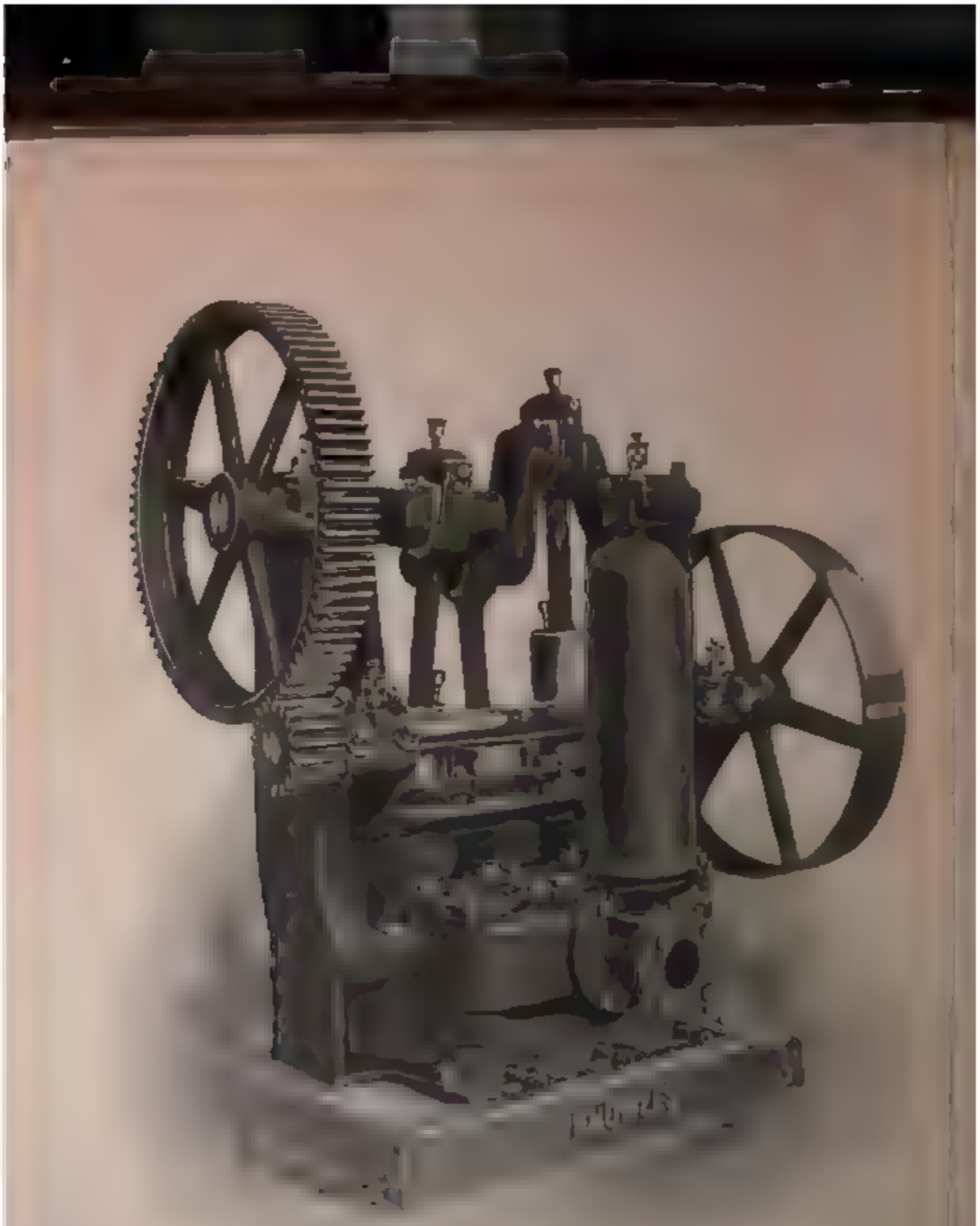
This pump is particularly adapted to hard hydraulic elevator service, where smooth and quiet action is necessary, and also to pulp mill work, where uniform pressure must be maintained.

When sending inquiries or orders, give us complete information regarding number of grinders, and size and number of hydraulic cylinders for each grinder, also pressure.

Sizes, Capacities, and Dimensions — Style G.

Diameter of Plungers	Stroke	Revolutions per Minute	Gallons per Revolution	Gallons per Minute	Suction	Discharge	Pulleys. Tight and Loose		Ratio of Gears	Dimensions over all			Code Word
							Diameter	Face		Length	Width	Height	
3	4	45	.3673	16.53	1½	1½	20	3	5 to 1	38¼	34	40½	Falconet
4	4	45	.6528	29.37	2	2	26	4	5 to 1	44⅛	40½	49½	Fallacy
4	6	40	.9787	39.15	2	2	30	5	5 to 1	49	43	54	Fallen
4	8	40	1.305	52.20	2	2	30	5	5 to 1	49	45	61	Fallible
5	6	40	1.530	61.20	3	3	30	5	5 to 1	61	51	66	Falling
5	8	40	2.040	81.60	3	3	36	6	5 to 1	63	54	72	Fallow
6½	8	40	3.448	137.92	4	4	42	6	5 to 1	71	68	76½	Falsehood

We have also a full line of patterns for these pumps arranged for operating by electric motors, geared *directly to them and mounted* on the same bed plate.



Knowles Vertical Triplex Power Pump—Style E

For Light Service

Size, 8x8

The Knowles Vertical Triplex Light Service Power Pump

For 100 Feet Lift.

THIS LINE of power pumps is designed for light work; and dimensions, capacities, etc., are to be found in table following.

Plungers are outside packed; boxes babbitted, hammered, and bored it to exact fit; and gears cut.

Each pump is furnished with tight and loose pulleys, and discharge r chamber, and has suction and discharge openings on opposite sides.

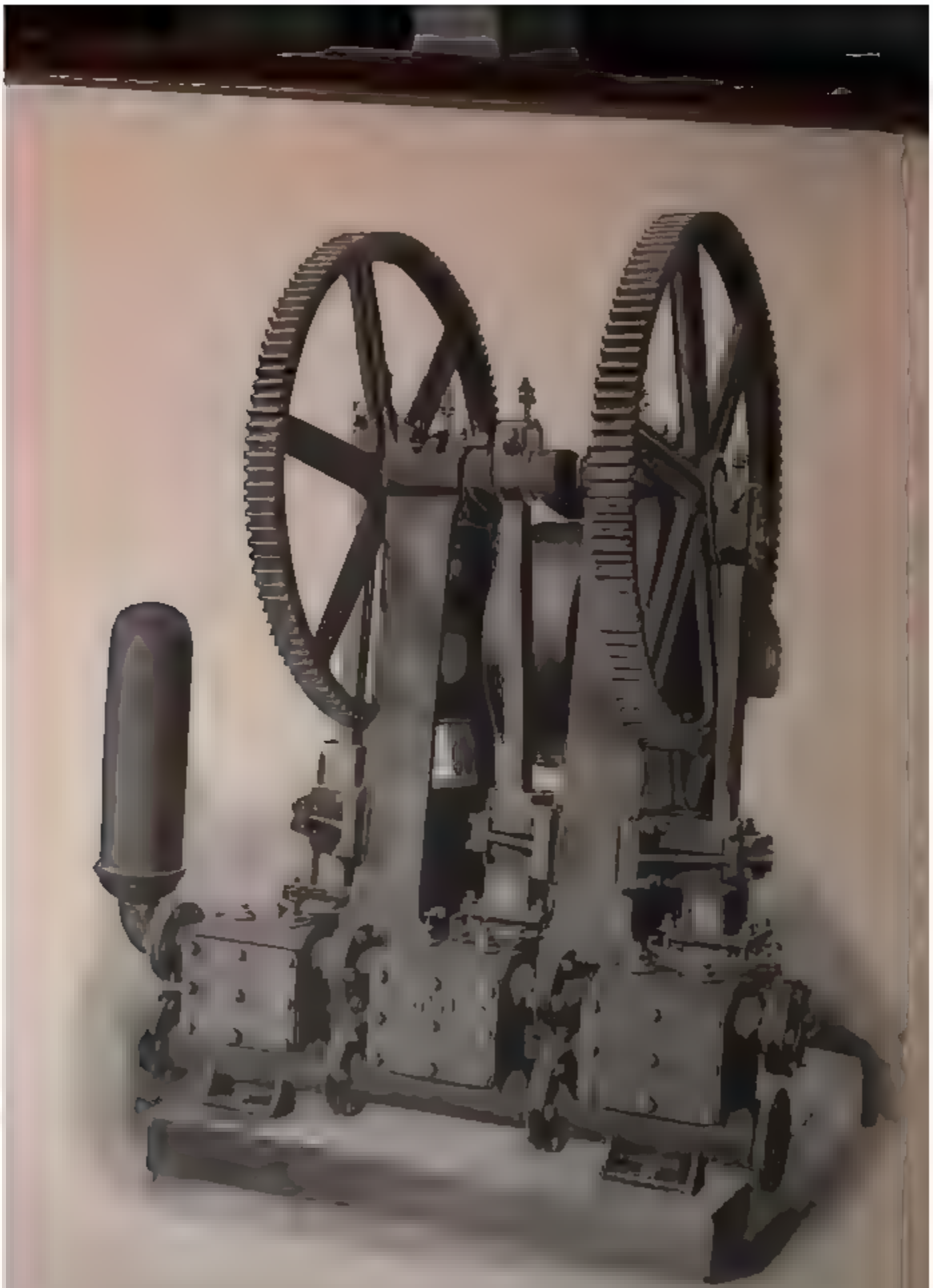
Boxes in the crank ends of connecting rods are provided for taking p wear.

In sending inquiries or orders, always state the water pressure.

Sizes, Capacities, and Dimensions — Style E.

Plungers	Stroke	Revolutions per Minute	Gallons per Revolution	Gallons per Minute	Suction	Discharge	Pulleys, Tight and Loose: Diameter	Pulleys, Tight and Loose: Face	Ratio of Gears	Dimensions over all: Length	Dimensions over all: Width	Dimensions over all: Height	Code Word
	4	45	.6528	29.37	2	2	20	3	5 to 1	32½	32½	34	Factive
	6	40	.9787	39.15	2	2	20	3	4 to 1	32½	32½	34	Factorage
	6	40	1.530	61.20	3	3	20	4	4 to 1	40¼	38	44	Factotum
	8	40	2.040	81.60	3	3	20	4	4 to 1	40¼	38	44	Factual
½	8	40	3.448	137.92	4	4	26	5	4 to 1	54	43	55	Facture
	8	40	3.998	159.92	5	4	30	5	4¼ to 1	54	43	55	Faculty
	8	40	5.222	208.88	5	4	30	6	5 to 1	59	43	57½	Facund
	10	40	6.525	261.00	5	4	36	6	5 to 1	59	43	57½	Faddle
	12	40	7.833	314.00	5	4	36	6	5 to 1	67	48	69	Fadeless

We have also a full line of patterns for these pumps arranged for erating by electric motors, geared directly to them and mounted on the me bed plate.



Knowles Vertical Triplex Power Pump—Style F

For Light Service

Size, 9x12

The Knowles Vertical Triplex Light Service Power Pump

For 100 Feet Lift.

THE CUT shows another pump, of larger capacity, designed especially for light work. The arrangement of cranks differs from the preceding style of pumps, in having supports for crank shaft between centre and outside cranks. This arrangement produces a smaller bending moment in the crank shaft, and is for this reason better adapted to these pumps of larger capacities.

Guides for plungers are provided, relieving much of the strain, and diminishing wear.

A feature of this pump is the provision of suction and discharge openings on either side, a very handy arrangement where space is restricted.

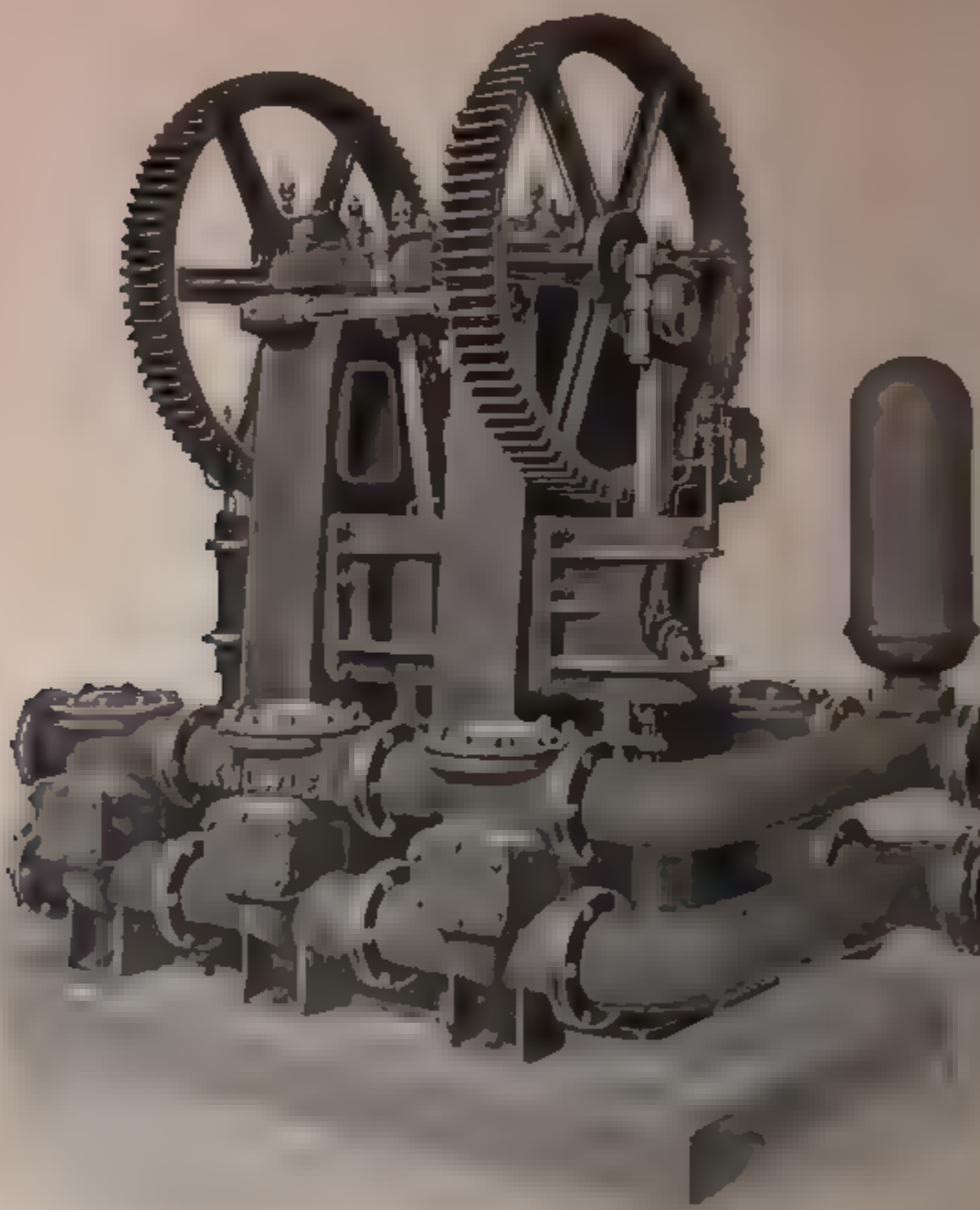
This class of pump is also made, when specially ordered, with connecting rods secured to independent crossheads, attached to the upper end of plungers; crossheads being fitted with adjustable shoes in the guides.

In sending inquiries or orders, always state the water pressure.

Sizes, Capacities, and Dimensions—Style F.

Diameter of Plungers	Stroke	Revolutions per Minute	Gallons per Revolution	Gallons per Minute	Suction	Discharge	Pulleys, Tight and Loose		Ratio of Gears	Dimensions over all			Code Word
							Diameter	Face		Length	Width	Height	
9	10	40	8.262	330	5	4	30	5	5 to 1	82	50½	82	Fairly
9	12	40	9.915	397	6	5	30	5	5 to 1	87	66	90	Fairness
10	12	40	12.243	490	8	7	30	6	5 to 1	87	66	95	Fairy
11	12	40	14.811	592	8	7	30	6	4.85 to 1	87	66	95	Fairylike
12	12	40	17.628	705	10	8	42	8	5 to 1	96½	78	101	Faith
13	12	[illegible]	20.685	827	10	8	42	8	5 to 1	96½	78	101	Faithful

We have also a full line of patterns for these pumps arranged for operating by electric motors, geared directly to them and mounted on the same bed plate.



Knowles Vertical Triplex Power Pump—Style I

Double Acting Piston Pattern

Size, 8x12

The Knowles Vertical Triplex Piston Pattern Power Pump

For Boiler Feeding. Also for Hydraulic Cylinders of Wood-pulp Grinders.

THIS PUMP is of the double acting piston pattern, and is designed to work against pressures as high as 130 pounds.

The crank shafts, connecting rods, crossheads, gears, etc., are well proportioned, and made of best material.

All bearings are arranged for taking up wear. Marine pattern connecting rods are used.

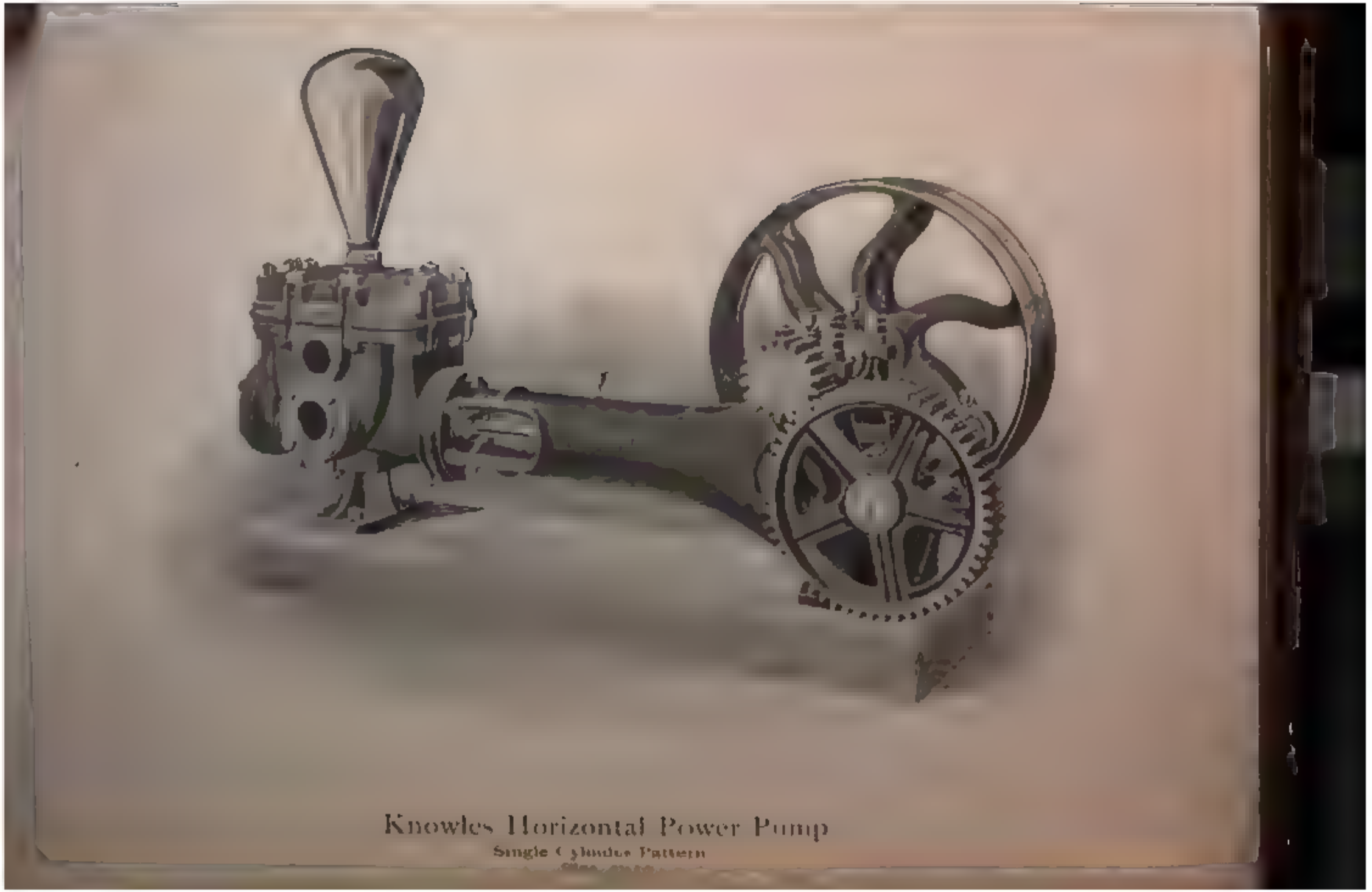
This pump also has suction and discharge openings on either side. For particulars in regard to dimensions, capacities, etc., see table below.

When sending inquiries or orders, always give us complete information regarding number of grinders, and size and number of hydraulic cylinders for each grinder; also pressure.

Sizes, Capacities, and Dimensions—Style I.

Diameter of Pistons	Stroke	Revolutions per Minute	Gallons per Revolution	Gallons per Minute	Suction	Discharge	Pulley		Ratio of Gears	Dimensions over all			Code Word
							Diameter	Face		Length	Width	Height	
6½	8	40	6.88	274	7	5	26	12½	5 to 1	65	57	83	Famous
6½	10	40	8.62	345	7	5	28	14½	5 to 1	77	62	92½	Famously
7	10	40	10.00	400	8	6	30	14½	5 to 1	77	62	92½	Fanatic
7	12	40	12.00	480	8	6	30	14½	5 to 1	88	70	100¼	Fancied
8	12	40	15.65	628	8	6	30	16½	4.72 to 1	89	70	100¼	Fanciful
9	12	40	19.83	793	10	8	36	16½	5 to 1	93	76	112	Fancy
10	12	40	24.48	979	12	10	40	18½	5 to 1	98	84	116½	Fandango
11	12	40	29.62	1188	12	10	45	20½	6 to 1	105	92	124	Fanged
12	12	40	35.25	1410	14	12	48	22½	6 to 1	113	107	133	Fangless

We have also a full line of patterns for these pumps arranged for operating by electric motors, geared directly to them and mounted on the same bed plate.



Knowles Horizontal Power Pump

Single Cylinder Pattern

The Knowles Horizontal Power Pump

Single Cylinder Pattern.

THE CUT on opposite page shows one of our improved power pumps, Double Acting Single Cylinder pattern, fitted with gears. We also make the same pump designed to drive directly by belt, without intermediate gearing. This style of pump has suction and discharge valves above the cylinder barrel, and is designed to stand a water pressure of 100 pounds per square inch. Adjustments are provided, so that wear can be taken up in all bearings, slides, and other parts subject to wear. Every part is carefully proportioned, and material and workmanship are of the best. All gears and pinions have machine cut teeth.

The best gun metal composition is used in the linings, stuffing boxes, valve seats, and pistons, the latter being suitably packed for hot or cold water or other liquids.

Heavy balance wheels are provided for all sizes.

The capacities in the table below are figured at the moderate speed of 80 feet piston travel per minute; this can be increased if desired.

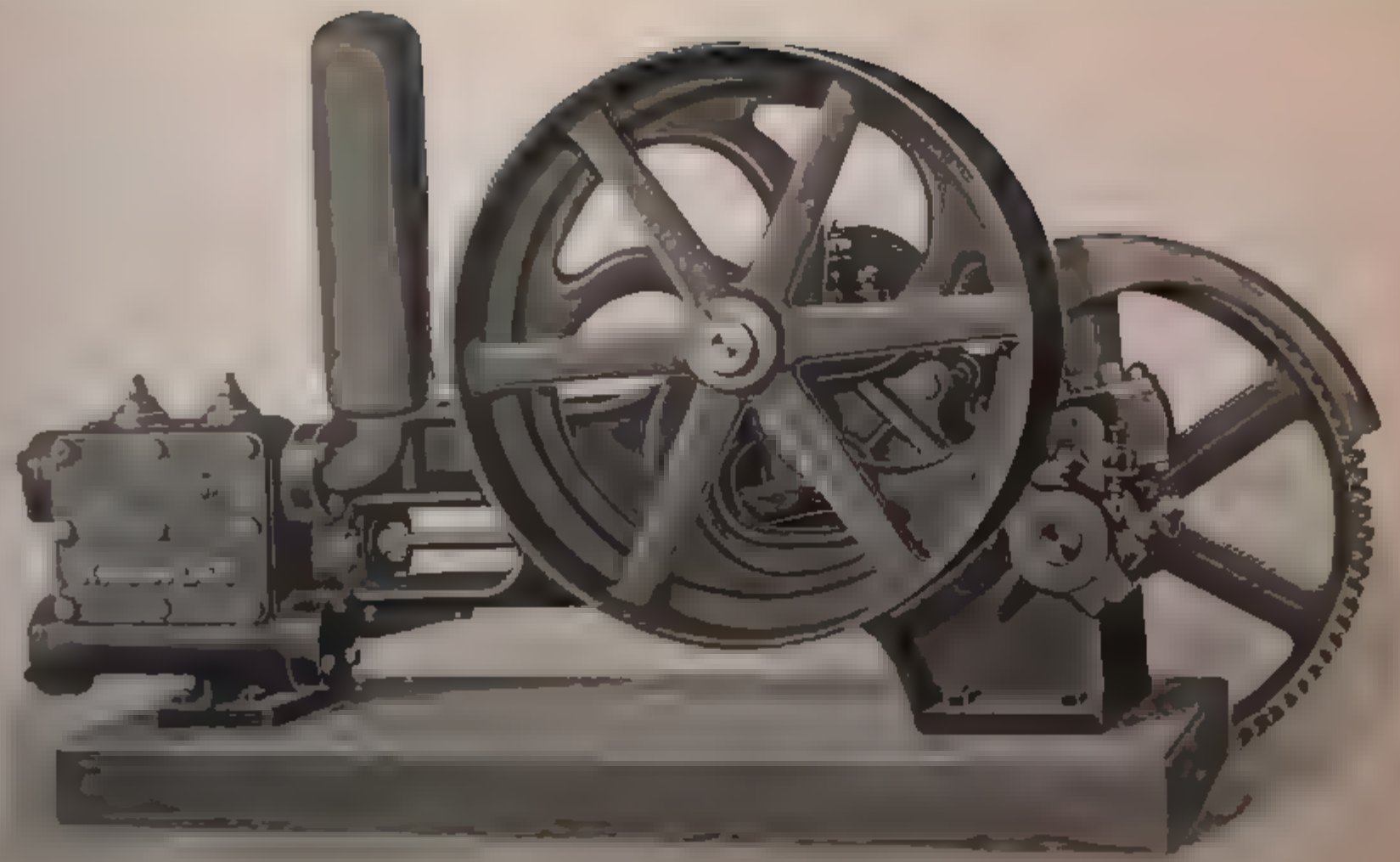
We have patterns also for power pumps arranged with *inside or outside plungers*, suitable for gritty or bad water.

When sending inquiries or orders, always state the pressure against which pump will have to work.

Sizes and Capacities.

Diameter of Piston	Stroke	Gallons per Revolution	Gallons per Minute	Suction	Discharge	Code Word	Diameter of Piston	Stroke	Gallons per Revolution	Gallons per Minute	Suction	Discharge	Code Word
3	6	.36	29	2	1½	Elusion	9	12	6 00	264	6	6	Embalmer
3¼	6	.43	35	2	1½	Elusive	10	12	8 14	326	6	6	Embank
3½	6	.57	46	2	1½	Elusory	10	16	10 86	326	6	6	Embargo
4	6	.66	52	2½	2	Eluted	10	24	16 32	326	6	6	Embase
3¼	10	.72	35	2½	2	Eluting	12	12	11 74	470	8	6	Embattle
3½	10	.96	46	2½	2	Eluxate	12	16	15 66	470	8	6	Embay
4⅛	10	1.11	54	3	2½	Elvan	12	24	23 48	470	8	6	Ember
4½	10	1.38	65	3	2½	Elvish	14	16	21.32	640	0	8	Embezzle
5	10	1.70	82	3	2½	Elysian	14	24	32.00	640	0	8	Emblaze
6	12	2.93	117	4	4	Emaciate	16	16	27 84	836		0	Emblem
7	12	4.00	160	5	5	Emanate	16	24	41.76	836	12	10	Embody
8	12	5.22	209	5	5	Embale							

Also patterns for larger sizes or other combinations.



Knowles Horizontal Power Pump

Steele Cylinder Pattern—For Heavy Pressure - 97 Frame Style

The Knowles Horizontal Power Pump

Single Cylinder Pattern. For Heavy Pressure. 97 Frame Style.

A POWER PUMP to be serviceable and durable must be strong, heavy, and mechanically put together. Unlike a direct-acting steam pump, the strains and resistances are not in a straight line; consequently, to insure success, a power pump must be thoroughly designed and constructed with special care.

We have had a long experience in building these pumps, and have patterns for all sizes, arranged for gear or pulley connections.

The water cylinders are of the double acting piston pattern The crank-shafts, connecting rods, crossheads, gears, and other parts are well proportioned and made of the very best materials. *Heavy balance wheels are provided for all sizes.* The bearings, slides, and all wearing parts are arranged for taking up when worn.

The cylinders have large water passages and valve areas. The linings, stuffing boxes, and valve seats are made of the best gun-metal composition, U. S standard. The pistons are also made of the same metal, suitably packed for the liquid to be handled

The pumps have protecting guards for gears, and are so arranged as to offer easy access to valves. All gears and pinions have machine cut teeth.

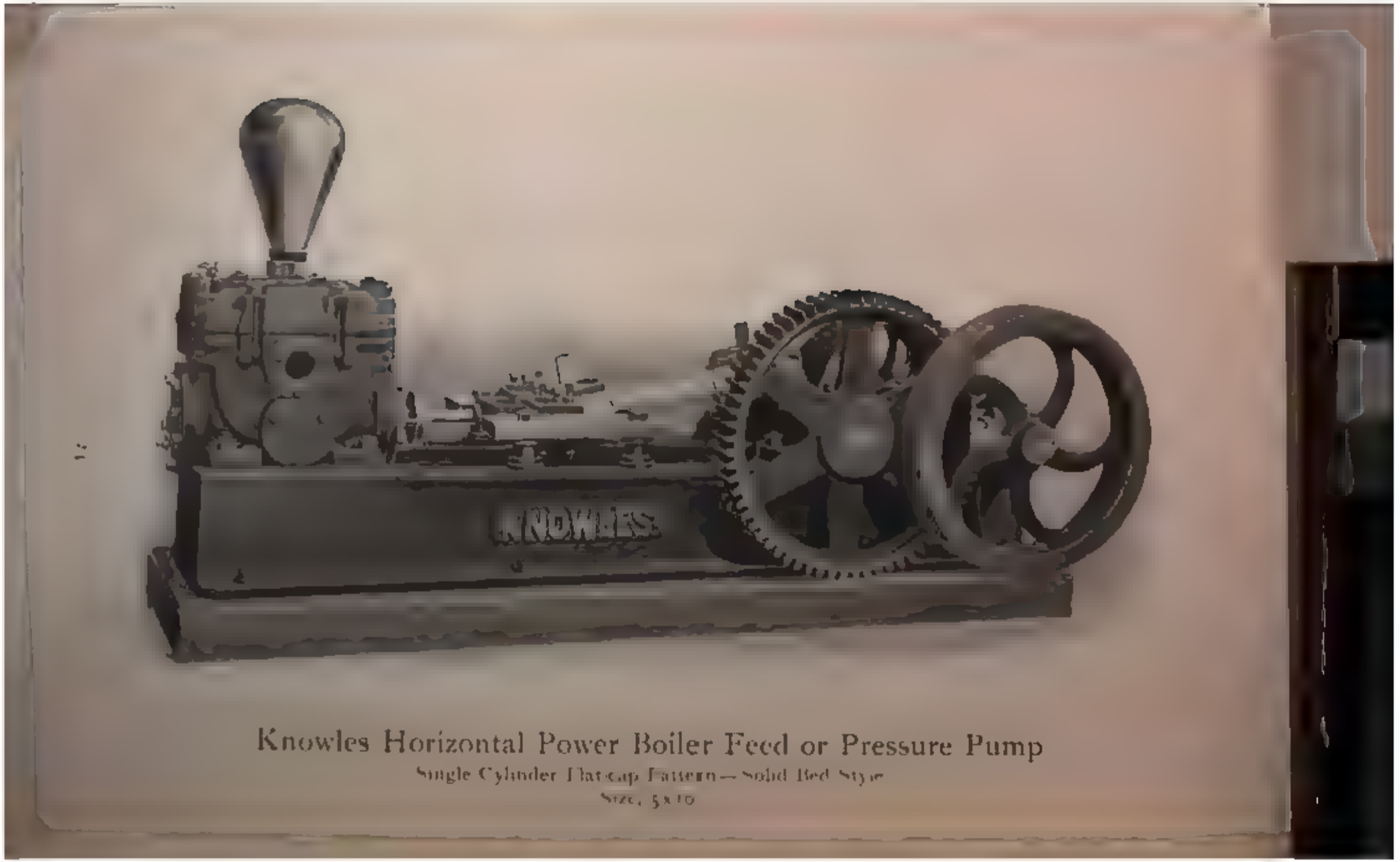
We have patterns, also, for power pumps arranged with *inside or outside plungers*, suitable for gritty or bad water. All sizes in the following list can be made for 125 pounds water pressure These pumps can also be constructed, if preferred, with water cylinders of the type shown on page 20.

When sending inquiries or orders, always state the pressure against which pump will have to work.

Sizes, Capacities, and Dimensions.

Diameter of Piston	Stroke	Gallons per Revolution	Gallons per Minute, at Moderate Speed	Suction	Discharge	Pulleys, Tight and Loose: Diameter	Pulleys, Tight and Loose: Face	Dimensions over all: Length	Dimensions over all: Width	Dimensions over all: Height	Code Word
3	6	.36	29	2	1½	24	3	50	20¼	29	Embolden
4	6	.66	52	2	1½	30	3	64	25	32	Embolism
4½	10	1.38	65	2½	2	30	4½	72	30	39	Embolus
5	10	1.70	82	3	2½	30	4½	72	30	39	Emborder
5½	10	2.06	99	3	2½	36	5½	82	37½	52	Emboss
6	10	2.45	117	4	3	36	5½	82	37½	52	Embottle
6½	10	2.87	138	4	3	36	5½	82	37½	59	Embow
7	10	3.33	160	5	4	36	5½	82	37½	59	Embowel
8	12	5.22	209	5	4	36	5½	86½	37½	46	Emboxed
9	12	6.61	264	6	5	48	8½	89	46	63	Embrace
10	12	8.16	326	6	5	52	8½	93	50	68	Embraid

Capacities are figured at 80 feet piston speed.



Knowles Horizontal Power Boiler Feed or Pressure Pump

Single Cylinder Flat-cap Pattern—Solid Bed Style

Size, 5x10

The Knowles Horizontal Power Boiler-Feed or Pressure Pump

Single Cylinder Flat-cap Pattern. Solid Bed Style.
Arranged for Hot or Cold Water or Other Liquids.

THIS PUMP is strong, heavy, and mechanically put together. Only the best materials are used; and the crank shafts, connecting rods, crossheads, gears, and other parts are well proportioned. Provision is made for taking up wear in bearings, slides, and all other wearing parts. All gears and pinions have machine cut teeth.

The water cylinders are of the double acting piston pattern, and have large water passages and valve areas.

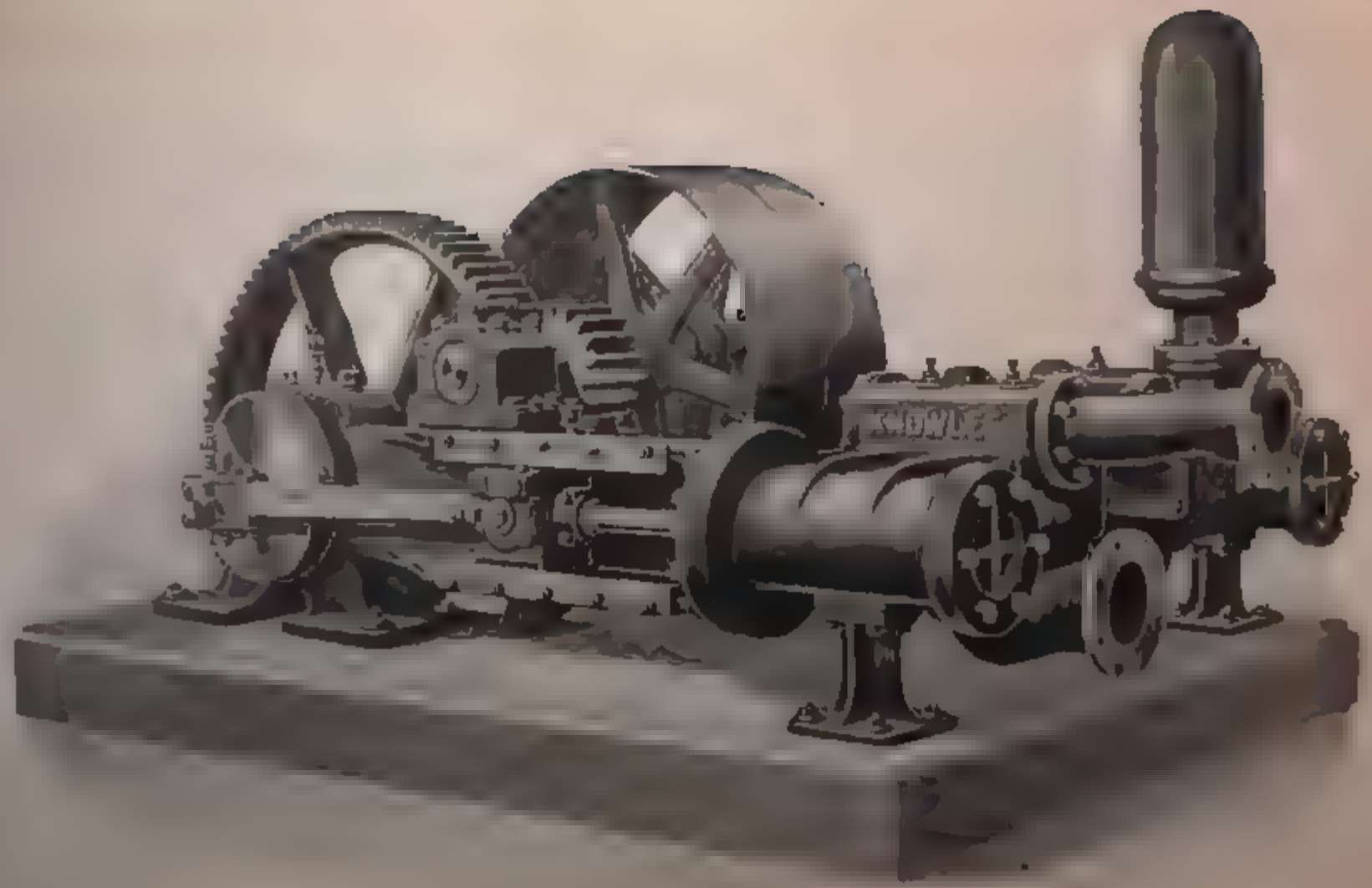
Best gun metal composition, U. S. standard, is used in linings, stuffing-boxes, and valve seats. The pistons are also of same material, and suitably packed for the liquid to be handled. *Heavy balance wheels are provided for all sizes.*

We have had a long experience in the manufacture of these pumps, and are provided with patterns for all sizes, arranged either for pulley or gear connections. We have patterns also for power pumps, arranged with *inside or outside plungers*, suitable for gritty or bad water. All sizes in the following list are suited for 100 pounds water pressure. When sending inquiries or orders, always state pressure against which pump will have to work.

Sizes and Capacities.

Diameter of Piston	Stroke	Gallons per Revolution	Gallons per Minute	Suction	Discharge	Code Word	Diameter of Piston	Stroke	Gallons per Revolution	Gallons per Minute	Suction	Discharge	Code Word
3	6	.36	29	2	1½	Embrave	9	12	6.60	264	6	6	Emery
3¼	6	.43	35	2	1½	Embroil	10	12	8.16	326	6	6	Emesis
3½	6	.57	46	2	1½	Embronze	10	16	10.86	326	6	6	Emetic
4	6	.66	52	2½	2	Embryo	10	24	16.32	326	6	6	Emeute
3¼	10	.72	35	2½	2	Embusy	12	12	11.74	470	8	6	Emigrant
3½	10	.96	46	2½	2	Emended	12	16	15.66	470	8	6	Emigrate
3¾	10	1.11	54	3	2½	Emerald	12	24	23.48	470	8	6	Eminence
4½	10	1.38	65	3	2½	Emerge	14	16	21.32	640	10	8	Eminent
5	10	1.70	82	3	2½	Emergent	14	24	32.00	640	10	8	Emissary
6	12	2.93	117	4	4	Emerited	16	16	27.84	836	12	10	Emission
7	12	4.00	160	5	5	Emeritus	16	24	41.76	836	12	10	Emitted
7	12	5.22	209	5	5	Emersion							

Also patterns for larger sizes or other combinations.
Capacities are figured at 80 feet piston speed.



Knowles Horizontal Duplex Power Pump

Girder Frame Type

The Knowles Horizontal Duplex Power Pump

Girder Frame Type. For Boiler Feeding. Also for Hydraulic Cylinders of Wood-pulp Grinders. Arranged for Hot or Cold Water or other Liquids.

THIS PUMP is designed for boiler-feeding, supplying hydraulic cylinders of wood-pulp grinders, or other hydraulic service. *It can be geared directly to the jack shaft of turbine water wheels, or can be driven by belt or gear connection from line shafting, run by water or steam power.*

Little head room is necessary in this style, and all parts are easily accessible for cleaning, adjusting, and repairing.

Thoroughness of design and best materials are carefully combined.

Composition gun metal is used for the valve seats and linings of the double-acting water cylinders. All bearings and slides are arranged so that wear can be taken up.

We also have patterns for larger sizes.

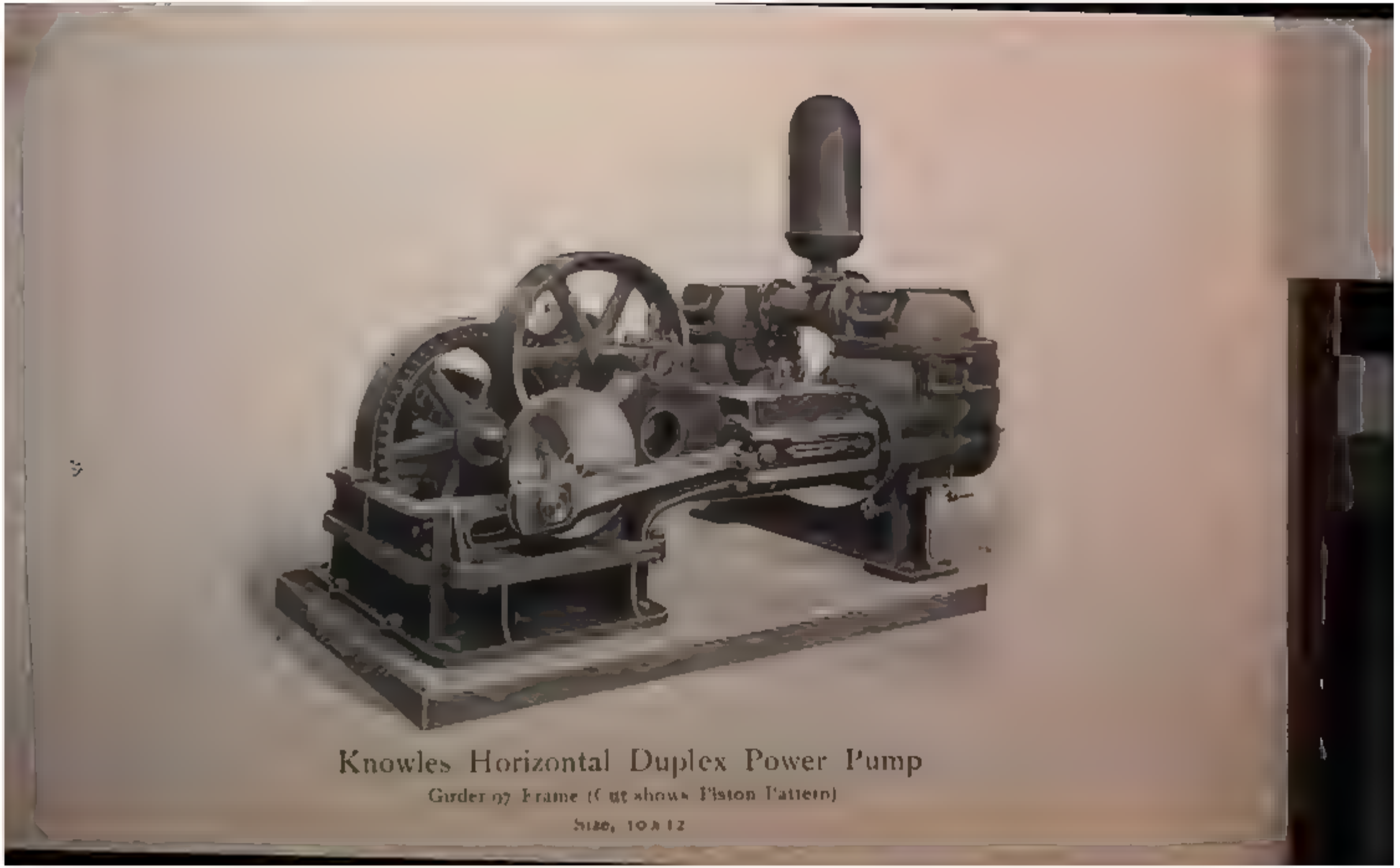
All sizes in the following list can be made for 125 pounds pressure.

When sending inquiries or orders, give us complete information regarding number of grinders, and size and number of hydraulic cylinders for each grinder; also pressure.

Sizes and Capacities.

Diameter of Pistons	Stroke	Gallons per Revolution (Both Cylinders)	Gallons per Minute	Suction	Discharge	Code Word
3¾	6	1.14	92	3	2½	Emmet
4½	6	1.65	132	4	3	Emmew
4½	10	2.75	132	4	3	Emmove
5½	10	4.11	197	5	4	Emmoving
6	10	4.89	235	5	4	Emotion
6½	10	5.75	276	5	4	Emotive
7	10	6.66	320	6	5	Empanel
7½	10	7.65	367	6	5	Empasm
8	12	10.44	418	8	6	Empeople
10	12	16.28	651	10	8	Emperor

The capacities are figured at moderate speed, namely, 80 feet piston travel per minute. The speed can be increased, making a corresponding increase in capacity.



Knowles Horizontal Duplex Power Pump

Girder 97 Frame (Cut shows Piston Pattern)

Size, 10 x 12

The Knowles Horizontal Duplex Power Pump

Piston or Inside Plunger Pattern. For Hydraulic Cylinders of Wood-pulp Grinders. Girder 97 Frame.

ANOTHER AND often-preferred form of grinder pump is the duplex horizontal pattern, as shown on opposite page; and frequently circumstances render it far more desirable. It requires little head-room, and every part is accessible for cleaning, adjusting, and repairing.

This pump is built for both light and heavy work.

This is one of the best all-around service pumps for a paper mill to use; it is good for a variety of purposes besides grinding; it makes an excellent boiler feeder or a water service pump where the elevation is great, as it is made strong for more than ordinary pressure. *It can be geared directly to the jack shaft of turbine water wheels or can be driven by belt or gear connection from line shafting run by water or steam power. It is also made for driving direct with belt pulley, dispensing with gears.*

The pump is designed with thoroughness. Each water cylinder is double acting and is arranged with lining and valve seats of composition gun-metal. All bearings and slides are fitted for taking up when worn. The crank shafts, connecting rods, cross-heads, gears, and other parts are well proportioned for heavy work, and made of the very best material.

The gears are machine cut, the most suitable for heavy pressure.

All sizes in the following list can be made for 130 pounds pressure.

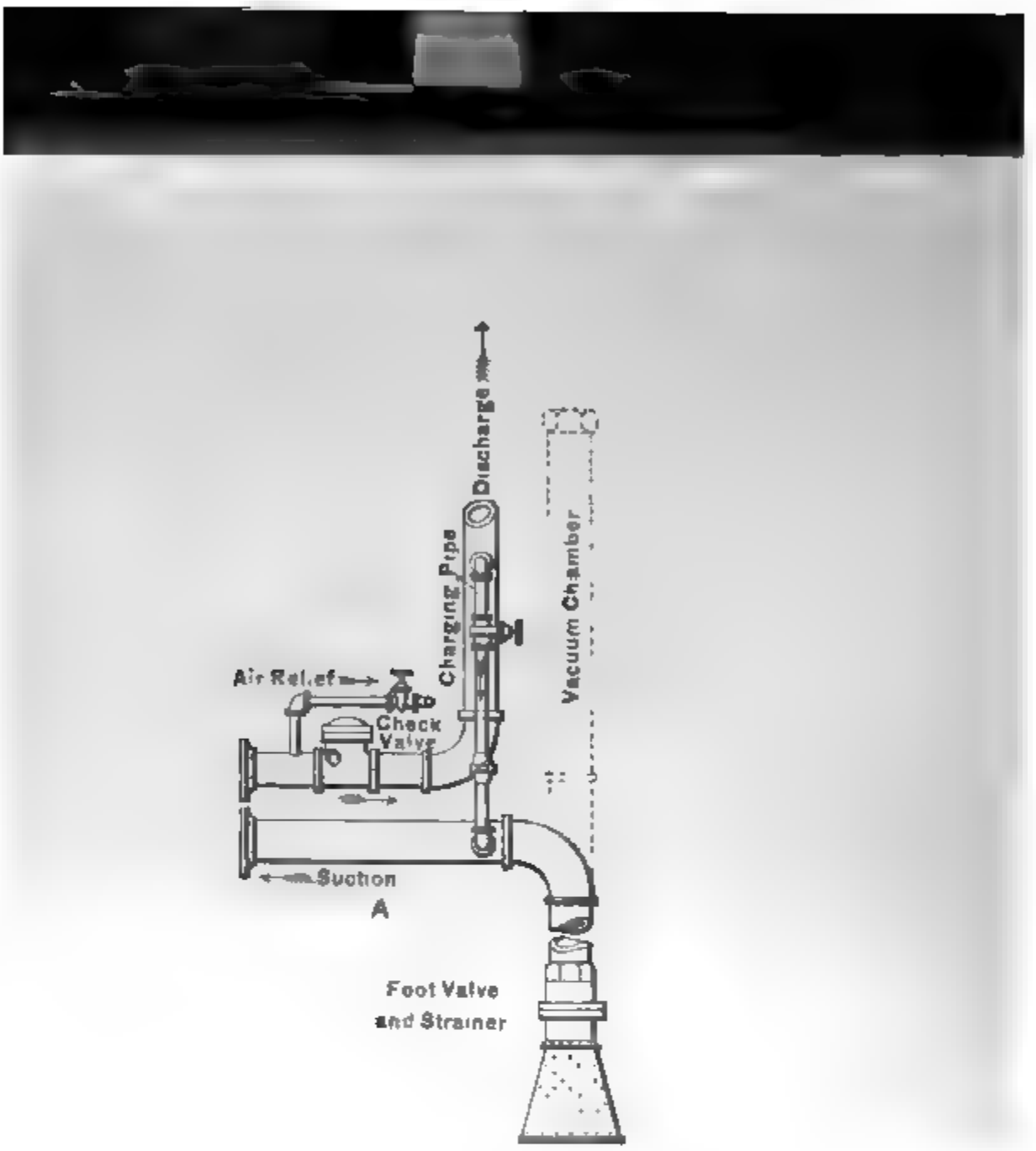
When sending inquiries or orders, give us complete information regarding number of grinders, and size and number of hydraulic cylinders for each grinder; also pressure.

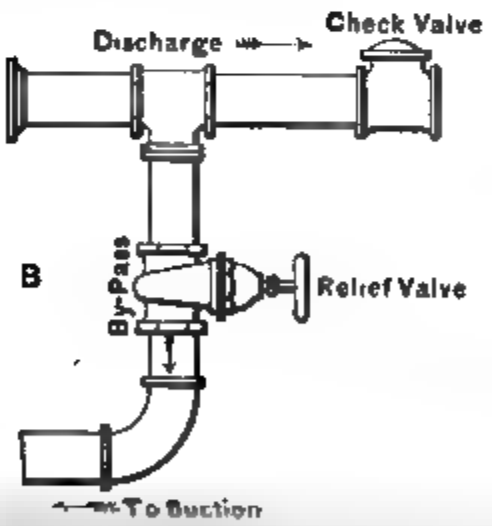
Sizes and Capacities.

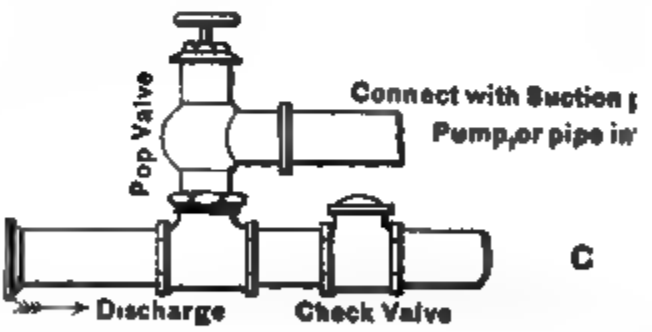
Diameter of Cylinders	Stroke	Gallons per Revolution (Both Cylinders)	Gallons per Minute	Suction	Discharge	Code Word	
						Piston Pattern	Inside Plunger Pattern
3¾	6	1.14	92	3	2	Emphasis	Emulous
4⅛	6	1.39	111	3	2	Emphatic	Emulsion
5½	6	2.47	198	5	4	Empight	Emulsive
5	12	4.08	163	5	4	Empiric	Enable
6	12	5.88	235	5	4	Emporium	Enabling
7	12	8.00	320	6	5	Empower	Enact
8	12	10.44	418	8	6	Empress	Enacting
9	12	13.20	528	10	8	Emprise	Enactive
10	12	16.28	651	10	8	Emption	Enactor
10	18	24.42	651	12	10	Empurple	Enambush
12	12	23.48	940	12	10	Empuse	Enamor
12	18	35.20	940	12	10	Empyema	Enarmed
12	24	46.97	940	14	12	Empyreal	Enate
14	18	48.00	1280	14	12	Emulate	Enaunter
14	24	64.00	1280	14	12	Emule	Encamp
16	18	62.66	1670	16	14	Emulge	Encamped
16	24	83.55	1670	16	14	Emulgent	Encanker

Also patterns for larger sizes or other combinations.

The capacities are figured at moderate speed, namely, 80 feet piston travel per minute. This speed can be increased if desired.







Plan of Piping for Knowles Power Pumps

Suggestions When Erecting and Operating Knowles Power Pumps

FOUNDATION — In all of the small sizes of our pumps sufficient foundation is afforded by a good plank floor, such as is found in any well constructed factory. For heavier pumps a more solid foundation should be used, such as brick, stone, or well rammed concrete, surmounted by a cap stone. Anchor bolts should be used in all cases.

Although our power pumps are self-contained, and not dependent upon foundation to preserve alignment of working parts, yet a good foundation preserves proper relative position of pump in regard to driving mechanism, and lessens strain and jar in piping.

That no delay may occur in setting the pump upon arrival, drawings showing location of bolt holes, flanges, and general dimensions will be sent upon receipt of order, when desired.

SUCTION PIPE — Use as short and direct suction pipe as possible. Use as few elbows as practicable; and in cases where the suction is long and several elbows occur, increase size of suction pipe. Never use smaller sizes than pump openings call for.

A vacuum chamber should be used in all cases of long suction pipe or high lift. This chamber may be made of pipe, as shown in sketch A; a volume of two per cent. of the pump capacity per minute giving good results.

A foot valve, with strainer attached, should be placed at the end of the suction pipe. See illustration A.

A light suction is an advantage, except in the case of pumping hot water; then the water should go to the pump under a slight head.

Be sure there are no leaks in the suction pipe.

[redacted]

DISCHARGE PIPE — Using as straight discharge pipe as possible, with long bends and gate valves, increases the efficiency of the pump. A check valve should be placed in the discharge pipe, as sketches A, B, and C show.

TO INSURE IMMEDIATE ACTION UPON STARTING UP — When a pump takes suction under difficult conditions, and air is present in the suction pipe and the pump, a charging pipe should be connected, as shown in sketch A. This charging pipe runs from a point in the discharge pipe, beyond the check valve, to suction pipe, and is provided with a gate valve. An air relief pipe is also inserted in the discharge pipe between the pump and check valve, also shown in sketch.

On starting the pump, open the valve in the charging pipe, and also in the relief pipe. Water thus flows from the reservoir or tank to the suction pipe, dispelling air through the relief pipe.

Any slight leakage from the plungers and glands should be piped to a drain.

When a power pump is used for boiler-feeding, it is run at a constant speed, calculated to give the maximum supply of water required at any time. This supply required varies; and rather than shut down the pump, a by-pass between the discharge and the suction pipe is inserted, as sketch B shows. The water can thus be fed continuously to the boiler; and intermittent feeding, which involves loss of heat to feed water as well as destructive influence to pump, can be avoided.

Overloading, causing high pressure and consequent injury, should be guarded against in every power pump. This is provided for by placing an automatic water relief valve, connected to the discharge pipe, close to the pump. (See sketch C, "pop" valve.) This valve should be set to open at a pressure well within the limits of the strength of the pump. When several boilers are fed by the same pump, this automatic relief valve is placed in the by-pass mentioned above and shown in sketch B. It is set to open at a slightly higher pressure than that carried on the boiler. The surplus feed water passes through this valve to the

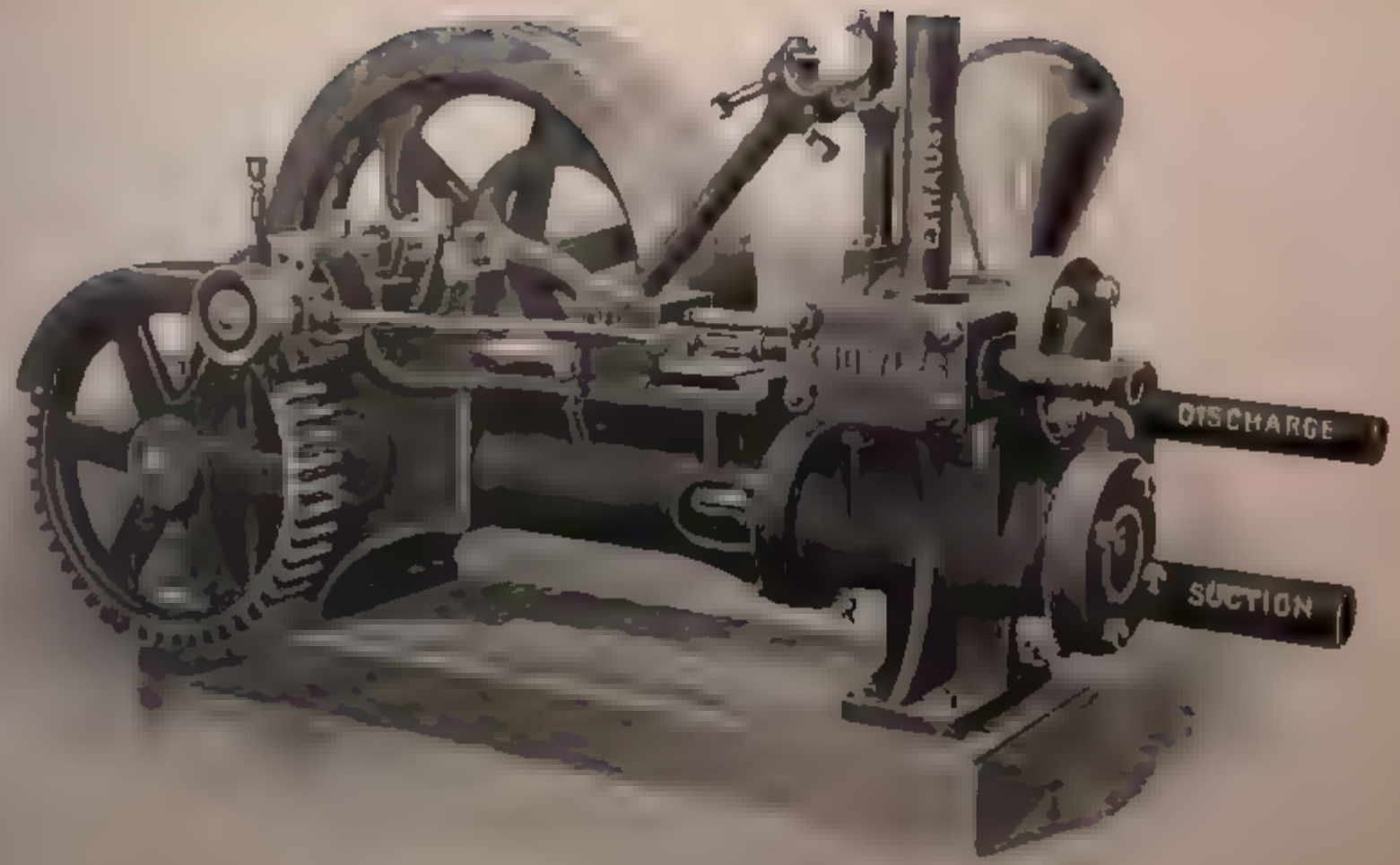
suction pipe or well, and the supply to each boiler is regulated by its stop valve.

Remember in all piping that a slightly longer pipe does not increase the friction nearly so rapidly as an elbow.

PACKING.—All stuffing boxes should be carefully packed, and glands brought up firmly against the packing; screwing up glands by hand should be sufficient, especially where hot water is used, which swells the packing.

Owing to improper adjustment of packing in pumps, feeding hot water to boilers under high pressure, it is often difficult to keep them tight. A packing to be good, should have a strong fibre, be well lubricated, and of such construction that slight pressure of the gland will cause it to hug the plunger.

A few new layers are often sufficient in repacking a pump; but old packing should be removed as soon as it becomes hard, otherwise it will cut the plungers.



Knowles Combined Steam and Power Pump

Single Cylinder Type

Size, 1½ x 5 – 3¼ x 6

[redacted]

ecial Apparatus Designed to Meet Varying Conditions

e Knowles Combined Steam and Power Pump

Single Cylinder Type. Patented.

E ILLUSTRATE on pages 34 and 36 two of the many special types of apparatus which we have from time to time built for our customers, to meet the requirements of peculiar conditions and surroundings.

his combined steam and power pump is especially adapted for boiler feeding, pumping must be carried on continuously, since in the daytime it can be used as er pump, and during the night, while the main engine is shut down, can be used as m pump. The connecting rod is designed to be quickly disconnected, as cut shows.

he introduction of these specialties in this catalogue is intended less as a suggestion se interested in engineering problems than to illustrate the facility with which our facturing resources can be drawn upon to meet the demands of all classes of pur rs. We are ready at any time to prepare specifications, plans, and estimates on ng apparatus for any possible service.

his pump embodies strength, compactness, and durability. The gears are cut, le noiselessly, and are protected by shields. Crossheads are made with special p for lost motion, and crank shafts are carried in large babbitted bearings.

ny of the following sizes can be made for 120 pounds pressure

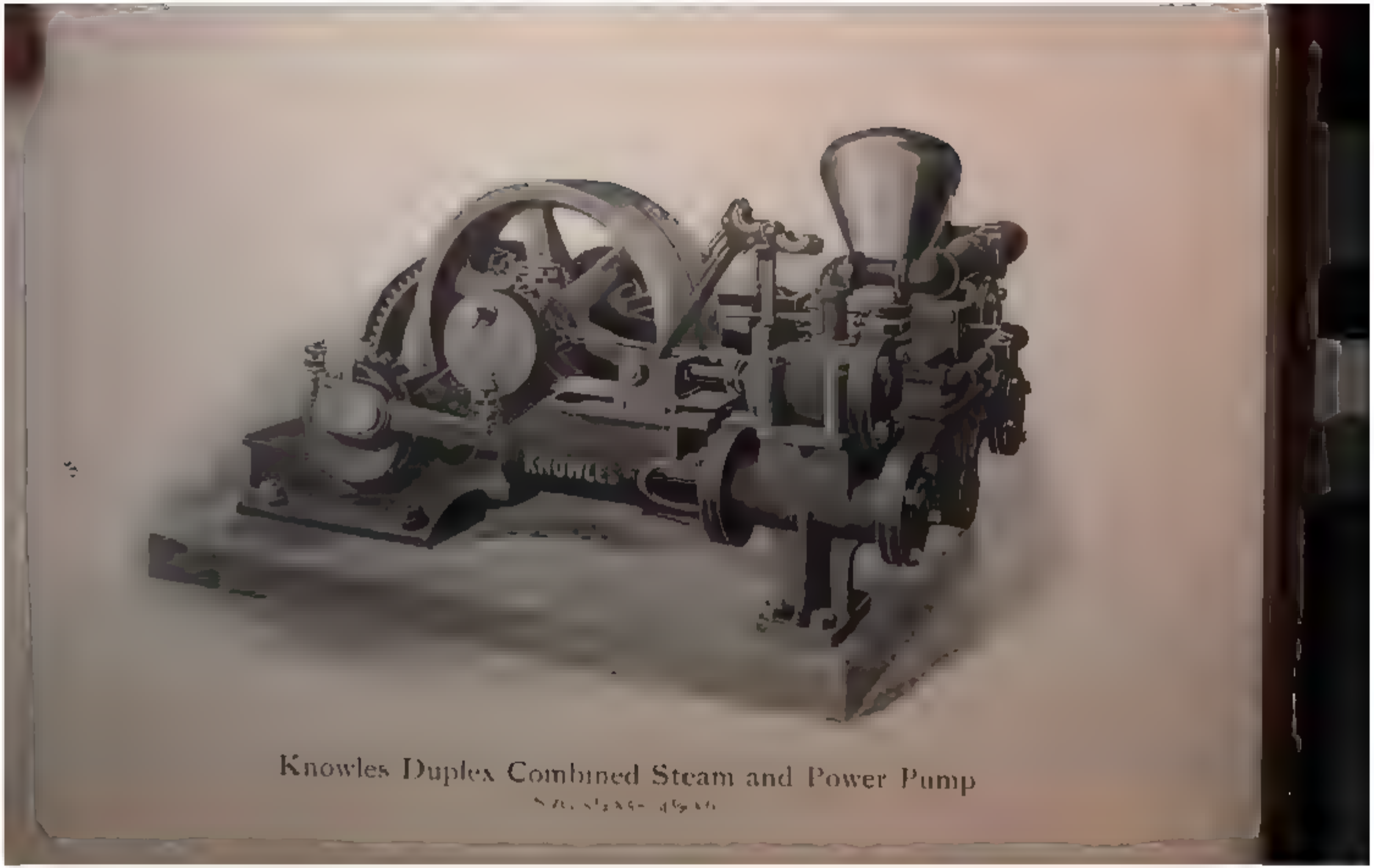
hen sending inquiries or orders, always state against what pressure the pump work.

Sizes, Capacities, and Dimensions

er	Pump Cylinder	Gallons per Revolution	Gallons per Minute	Suction	Discharge	Steam Pipe	Exhaust Pipe	Length	Width	Height	Pulleys, Tight and Loose: Diameter	Pulleys, Tight and Loose: Face	Code Word
5	3 x 6	.36	22.0	2	2	¾	1	48	21¼	25½	24	3	Encave
5	3¼ x 6	.57	34.2	2	2	¾	1¼	48	21¼	25½	24	3	Encaving
5	4½ x 6	.82	49.3	2½	2	¾	1½	55	25	36¾	24	4	Encema
8	4½ x 10	1.37	49.3	3	2½	¾	1½	73	30	39	30	4½	Enchafe
8	5 x 10	1.70	60.0	3	2½	¾	1½	82	30	39	30	5½	Encham
8	5 x 10	1.70	60.0	3	3	¾	1½	73	30	39	30	5½	Enchant
8	5½ x 10	2.05	73.8	3	2½	¾	2	82	37½	52	36	5½	Enchanted
8	6 x 10	2.45	87.6	4	3	¾	2	82	37½	52	36	5½	Encharge
8	6½ x 10	2.87	103.3	4	3	¾	2	82	37½	52	36	5½	Enchase
8	7 x 10	3.33	119.8	5	4	¾	2	82	37½	52	36	5½	Enchisel
10	8 x 12	5.22	156.5	5	4		2½	84	40	60		6½	Encircle
10	8½ x 12	5.90	176.5	6	5	2	2½	86	44	60	42	8½	Enclasp
10	8¾ x 12	6.24	187.5	6		2	2½	86	44	60	48	8½	Enclitic
10	9¼ x 12	6.98	209.0	6	5	2	2½	89	46	63	48	8½	Encoffin
10	9½ x 12	7.36	220.8	6	5	2½	3	89	46	63		8½	Encomion
10	10 x 12	8.16	244.6	6		2½	3	93	50	68	52	8½	Encore
10	10¼ x 12	8.57	257.0	6		2½	3	93	50	68	52	8½	Encoring

These pumps may also be electrically driven.

Capacities are figured at 60 feet piston travel per minute.



Knowles Duplex Combined Steam and Power Pump

The Knowles Duplex Combined Steam and Power Pump

Patented

THE CUT on the opposite page shows a Duplex Combined Steam and Power Pump One of the connecting rods is shown disconnected d laid back on a special support made for it; the other rod may be sconnected in the same way, and the pump made ready to drive with wer.

This type, like all other horizontal pumps, requires little head room. sts firmly on its foundation, and all parts are easily accessible.

For a pump to run continuously, whether for boiler feed or other rvice, these combined pumps have no equal.

Superior ingenuity and skill have been employed in the design of ese machines. In their construction, only the best material is used.

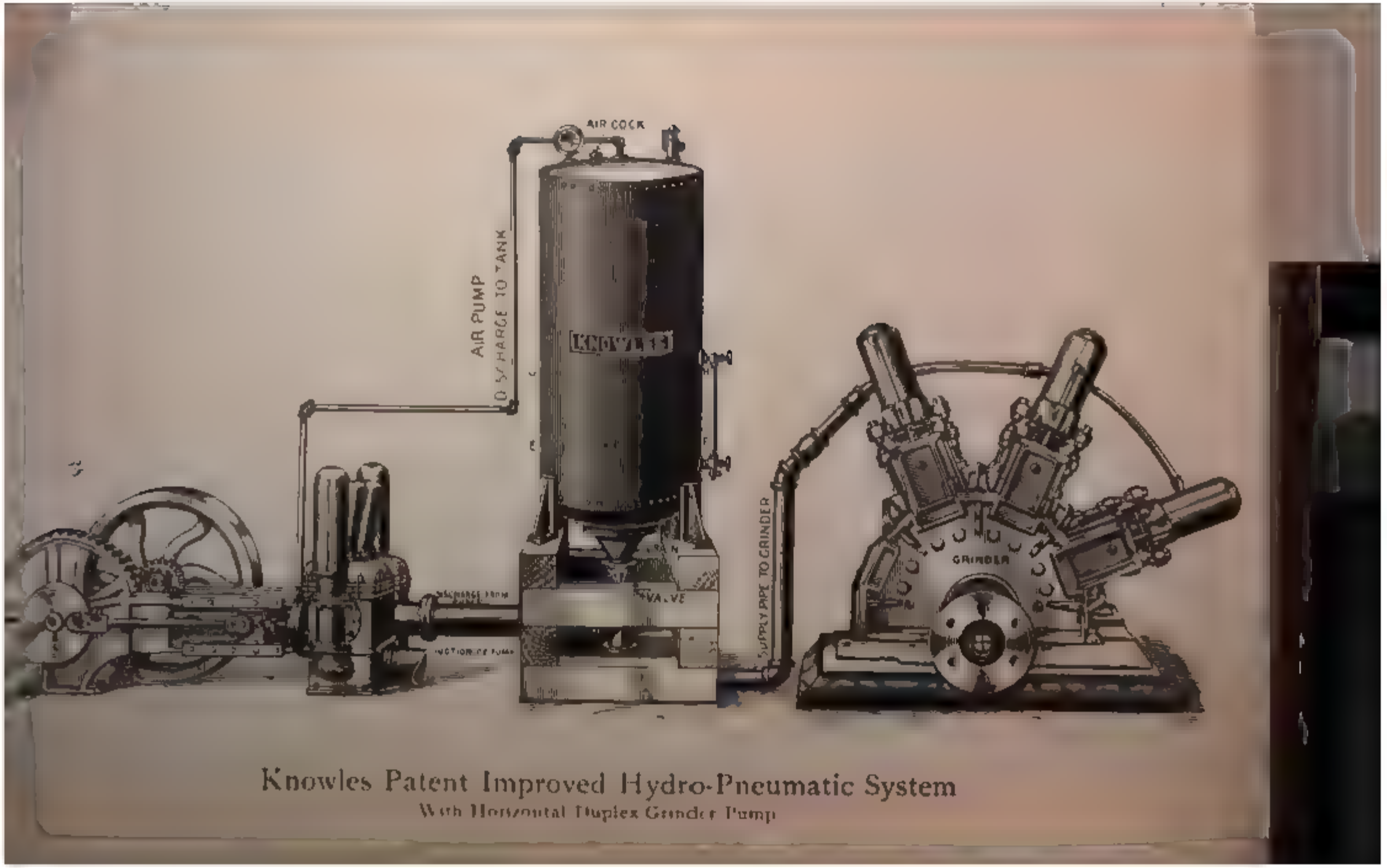
Adjustment for lost motion, due to wear, is provided for in the ossheads. Large babbitted bearings are supplied for the crank shafts, and e gears are provided with shields. These pumps may also be electrically iven.

Any of the following sizes can be made for 120 pounds pressure. hen sending inquiries or orders, always state against what pressure the ump must work.

Sizes, Capacities, and Dimensions.

Steam Cylinder	Pump Cylinder	Gallons per Revolution (Both Cylinders)	Gallons per Minute	Suction	Discharge	Steam Pipe	Exhaust Pipe	Length	Width	Height	Pulleys, Tight and Loose: Diameter	Pulleys, Tight and Loose: Face	Code Word
4½ x 5	3¼ x 6	1.14	69	3	2½	½	2	48	32½	26	24	3¼	Encradle
4½ x 5	4½ x 6	1.65	99	4	3	½	2	67	62	47¼	24	5¼	Encrinal
5½ x 8	4⅜ x 10	2.75	99	4	3	½	2	73	49	39	30	5¼	Encroach
5½ x 8	5½ x 10	4.11	48	5	4	2	2½	84	63	15	36	6¼	Endamage
5½ x 8	6 x 10	4.89	76	5	4	2	2½	84	63	45	40	6¼	Endanger
x 8	6½ x 10	5.75	207	5	4	2½	3	85	68	48	40	8¼	Endear
x 9	7 x 10	6.66	240	6	5	2½	3	85	68	48	42	8¼	Endeavor
5½ x 9	7½ x 10	7.65	5	6	5	2½	3	88	72	52	4	9¼	Endemic

Above capacities are figured on the basis of 60 feet piston speed er minute.



Knowles Patent Improved Hydro-Pneumatic System

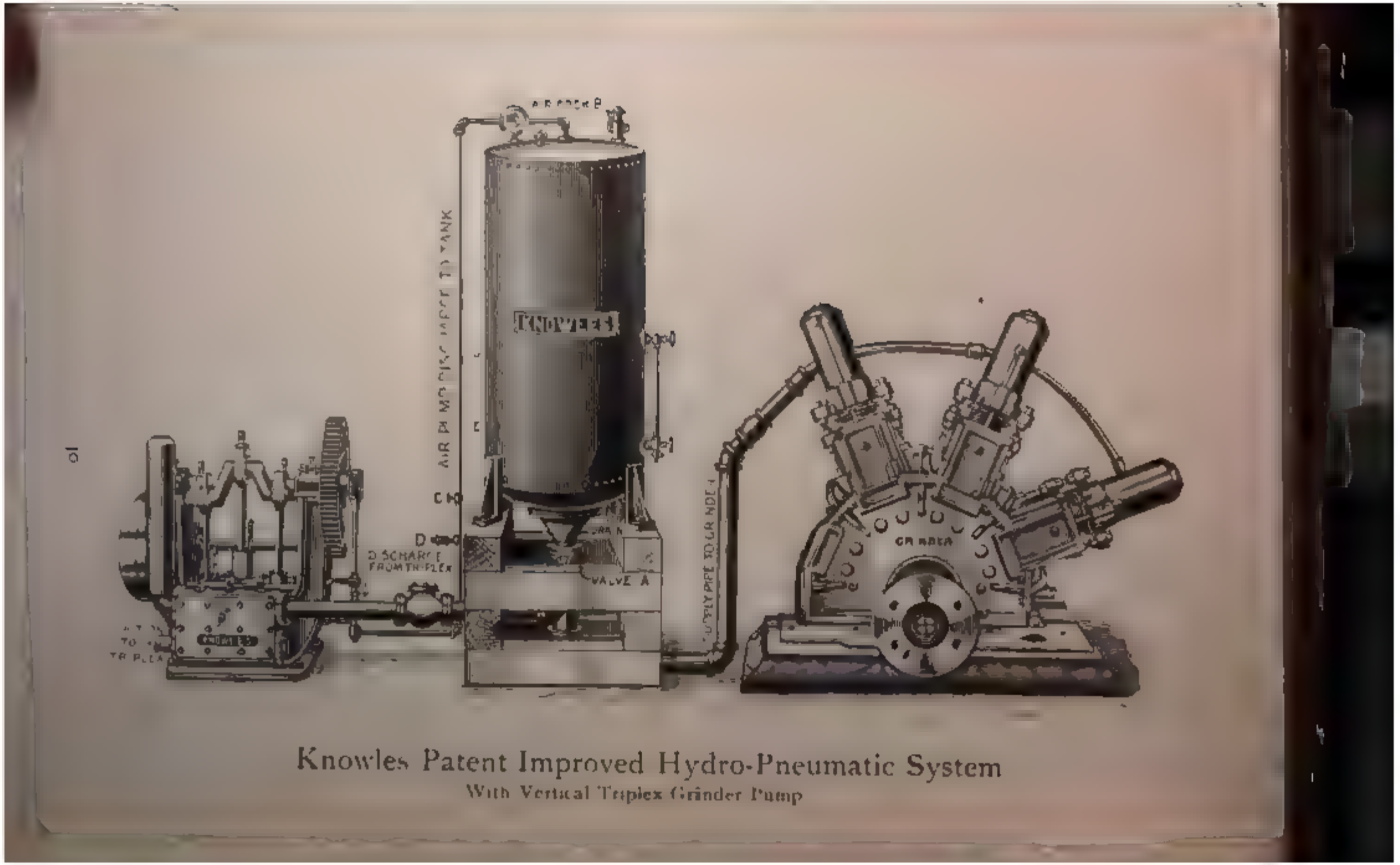
With Horizontal Duplex Grinder Pump

The Knowles Patent Improved Hydro-Pneumatic System

For Hydraulic Grinders in Paper Pulp Mills. (In Combination with Horizontal Duplex Grinder Pump.)

WE MANUFACTURE an improved hydro-pneumatic system for hydraulic grinders, to be used in connection with vertical or horizontal duplex power pumps. The air compressor required for the system may be connected directly to some reciprocating part of the pump, or it may be independent, of the vertical, triplex, single-acting type. This system will produce an even, continuous pressure throughout the entire grinders, and thereby give an unvarying pressure on the grinder pockets, producing an even pulp as well as a steady pressure whenever any of the grinders are thrown out, increasing also the output of the grinders. The apparatus is perfectly automatic, and responds very quickly when one or more grinders are thrown off or on.

We also make hydro-pneumatic apparatus of the accumulator type, connected directly on the main supply grinders. The accumulator piston in this apparatus is controlled by means of a plug valve, giving the desired action; and the position of piston can be maintained practically uniform, as it will respond very quickly to the opening or closing of ports. The upper part of the accumulator is an air cylinder, which balances the amount of water pressure, the air being supplied from a small compressor connected directly to the pump. This compressor will maintain exactly the pressure desired in the force main.



Knowles Patent Improved Hydro-Pneumatic System

With Vertical Triplex Grinder Pump

The Knowles Patent Improved Hydro-Pneumatic System

For Hydraulic Grinders in Paper Pulp Mills. (In Combination with Vertical Triplex Grinder Pump.)

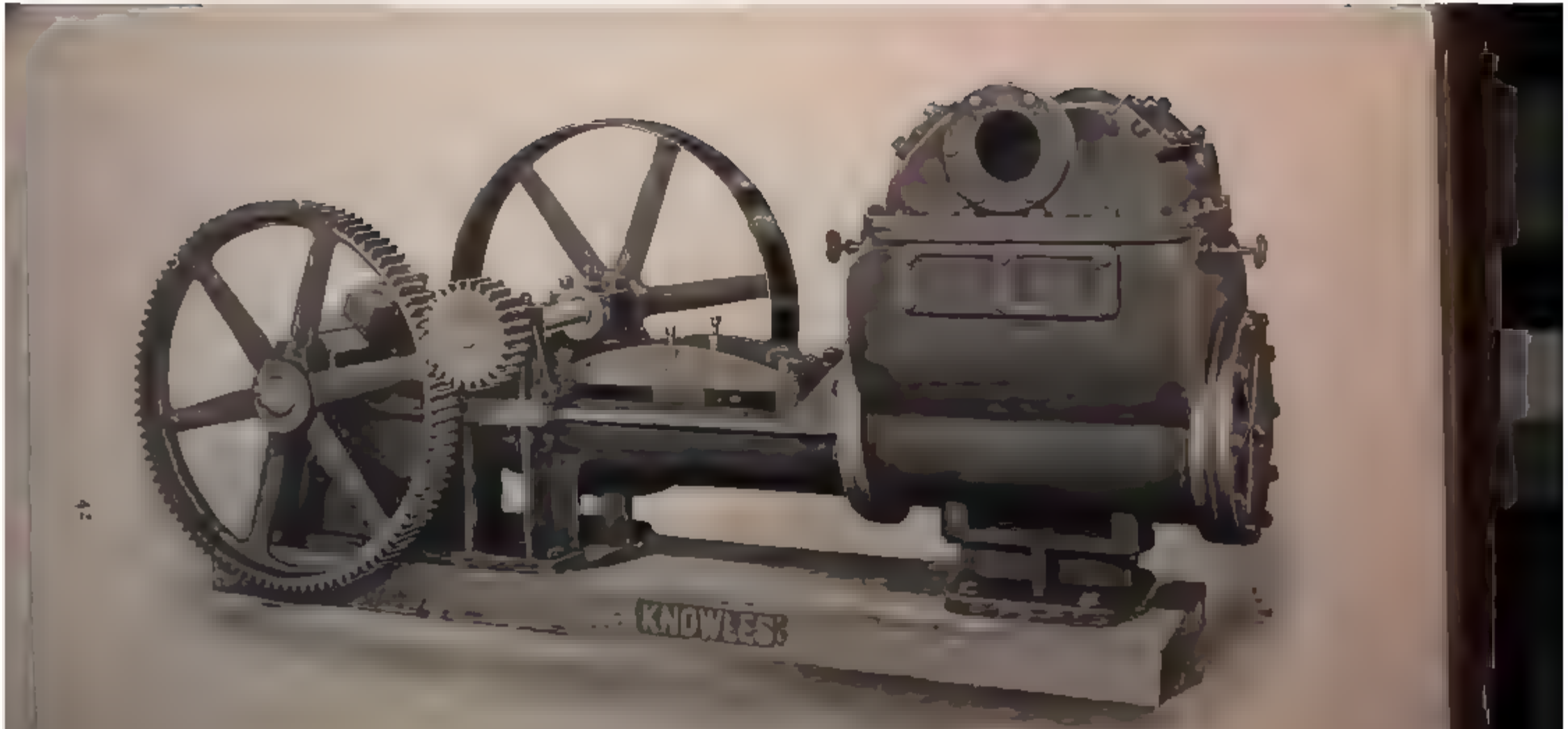
EITHER OF the hydro-pneumatic systems described on page 39 will insure absolute uniformity of pressure on the grinders, while the flexibility of the system is such that there is never any escape of water, a governing device being provided to regulate the supply of water according to requirements. In this way the largest possible amount of pulp is ground with a given amount of water pumped.

We invite correspondence on this particular point, and will make special designs suitable for different situations. We have these hydro-pneumatic systems in operation throughout the largest paper mills in the country.

INSTRUCTIONS WHICH ARE TO BE FOLLOWED CAREFULLY IN OPERATING COMPRESSOR AND TANK

When starting, close communication between air tank and pump by closing valve A. Drain tank and open air cock B to admit free air. When tank is drained and full of atmospheric air, close drain and air cock B; then open valve C and close valve D. Keep pumping air in until pressure gauge indicates a pressure within 10 pounds of that on grinders; then open valve A, and apparatus is in working condition.

Should air level reach the line E F, shut off air compressor by closing valve C and opening valve D, and let same be inoperative until air level is raised to line G H; then open valve C and close valve D. It will take about twelve hours to bring air level down to its lowest level, E F. This is the lowest level that air should be kept, to prevent air going into main discharge pipe to grinders. After once started, with air tank full of air at 80 pounds pressure, all the compressor will have to do is to make up for loss; hence, it will not be required to work continuously. Practical experience will determine the necessary time for air compressor to work.



Knowles Horizontal Geared Double-Acting Vacuum Pump

Size, 16x16

The Knowles Horizontal Geared Double-Acting Vacuum Pump

"Close Clearance" Type for Paper Machine Suction Boxes.

SUCTION BOXES on Fourdrinier machines require a steady vacuum, to be increased or diminished according to the quality of the paper to be made These pumps are designed especially for such work. The great number in use have proved themselves the most economical devices for the purpose, as they have required the least attention, the least expense for repairs, and the least power consumed in driving. The valves on ends of cap are kept closed unless the pump fills only on one end of cylinder, by opening either valve, the corresponding end of the cylinder is primed and the work of the piston is equalized.

These pumps are made geared as shown, or with the driving pulley mounted on crank shaft. The suction opening is on top, and the discharge on either side; or the suction opening may be placed on either side if desired.

The cylinders are lined with composition metal, and we can also furnish a *removable cast composition gun metal lining*, if specially ordered, although our regular standard lining can be easily removed and replaced.

The connecting rod is of forged steel. Boxes are adjustable and made of phosphor bronze Valves are of best soft rubber, of large area and easy of access. Piston rod is of rolled Tobin bronze, having a high tensile strength.

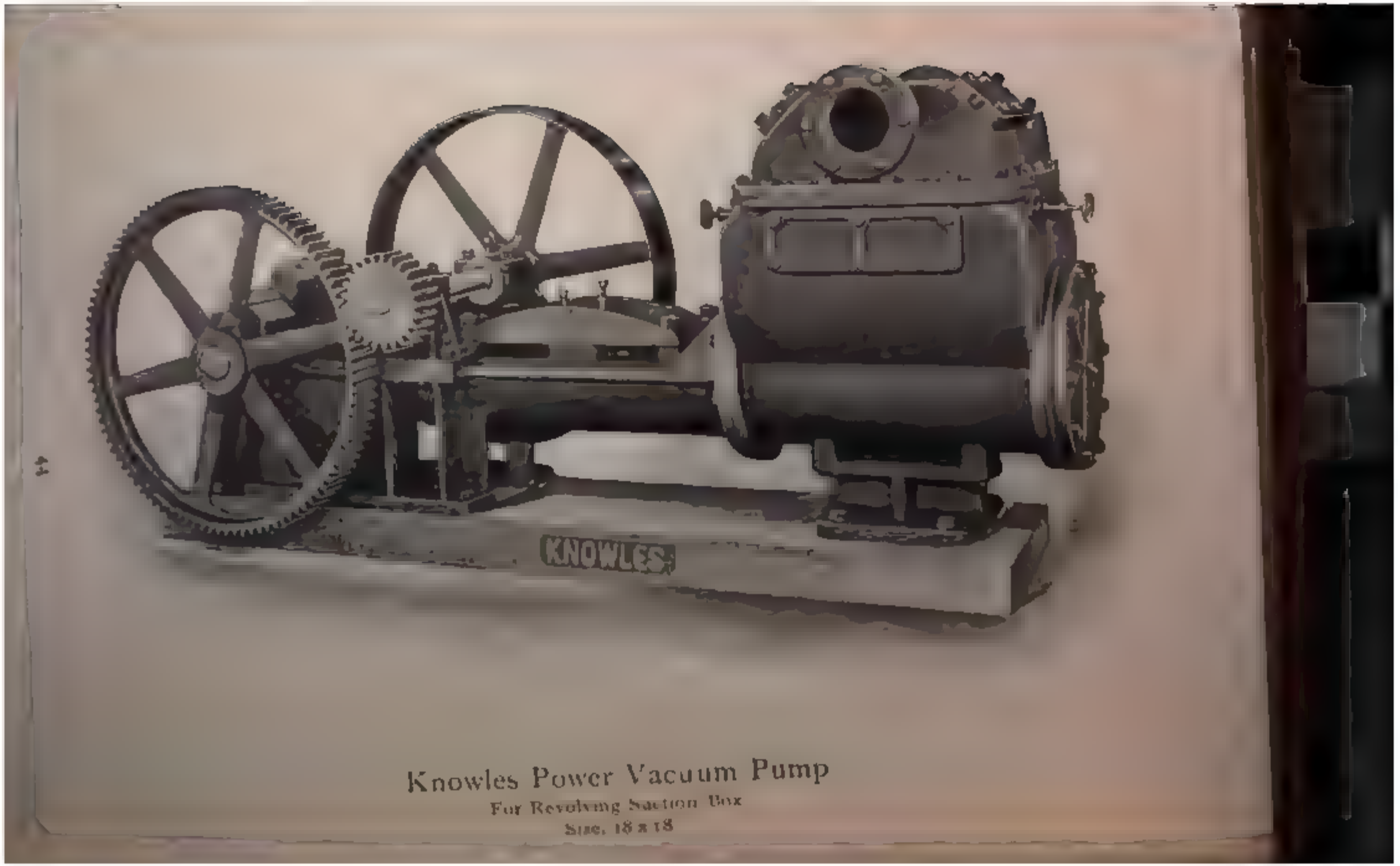
Adjustments for taking up wear are provided in cross-heads and guides. The piston is fitted with square flax packing. We advise the geared pumps for use with fast running shafting such as is commonly employed for modern paper machines making newspaper, the speed being properly reduced by means of the gearing on the pump

Where noiseless operation is required, we make these pumps belted, thus doing away with gears, using a small driving pulley on the line shaft and a large pulley on crank shaft of pump. Geared pumps will allow the use of pulleys of about equal diameters, and a higher belt speed.

When inquiring about suction pumps, always give range of speeds and width of paper machine, number of suction boxes, kind of stock used, weights of paper made, and general working conditions.

Sizes and Capacities.

Diam. of Piston	Stroke	Gallons per Revolution	Revolutions per Minute	Gallons per Minute		Suction	Discharge	Geared Pump: Pulley Diam	Pulley Face	Rate of Gears	Code Word	Pump Belted Without Gears: Pulley Diam	Pulley Face	Code Word
3	10	4.35	40 to 60	174 to	261	3½	3	30	4	4 to 1	Endemize	48	4	Endowing
10	10	6.8	40 to 60	272 to	408	5	4	30	4	4 to 1	Endive	48	5	Endrudge
12	10	9.6	30 to 50	288 to	480	5	5	30	5	4 to 1	Endless	48	6½	Endore
14	10	13.2	30 to 50	396 to	660	6	5	30	6	4 to 1	Endlong	48	8½	Enduring
16	12	20.9	30 to 50	627 to	1045	8	6	40	6½	4 to 1	Endmost	54	10½	Enecate
16	16	27.9	35 to 40	975 to	1114	8	6	42	6½	4 to 1	Endocarp	60	10½	Enemy
16	18	31.3	30 to 35	939 to	1095	8	6	42	6½	4 to 1	Endogen	60	12½	Enervate
18	16	35.2	30 to 35	1056 to	1232	10	8	42	6½	4 to 1	Endow	60	12½	Enerve
18	18	39.7	30 to 35	1189 to	1388	10	8	42	8½	4 to 1	Endower	66	12½	Enerving



Knowles Power Vacuum Pump

For Revolving Suction Box

Size, 18 x 18

The Knowles Power Vacuum Pump

For Revolving Suction Box.

ONE OF the most recent improvements on machines that manufacture straw board, is the *Revolving Suction Box.* To produce a vacuum on this apparatus requires a most efficient pump; and we recommend for the work one designed similarly to those attached to ordinary suction boxes, but larger in capacity and more substantially built.

This pump is also suitable for other work where a vacuum is produced by removing large quantities of air.

The composition fittings enumerated on page 43 apply also to this pump. We provide check valves on each end of the air cylinder connected to a common pipe having a gate valve; this is to prime the air cylinder with water from an outside tank, to keep the cylinder cool.

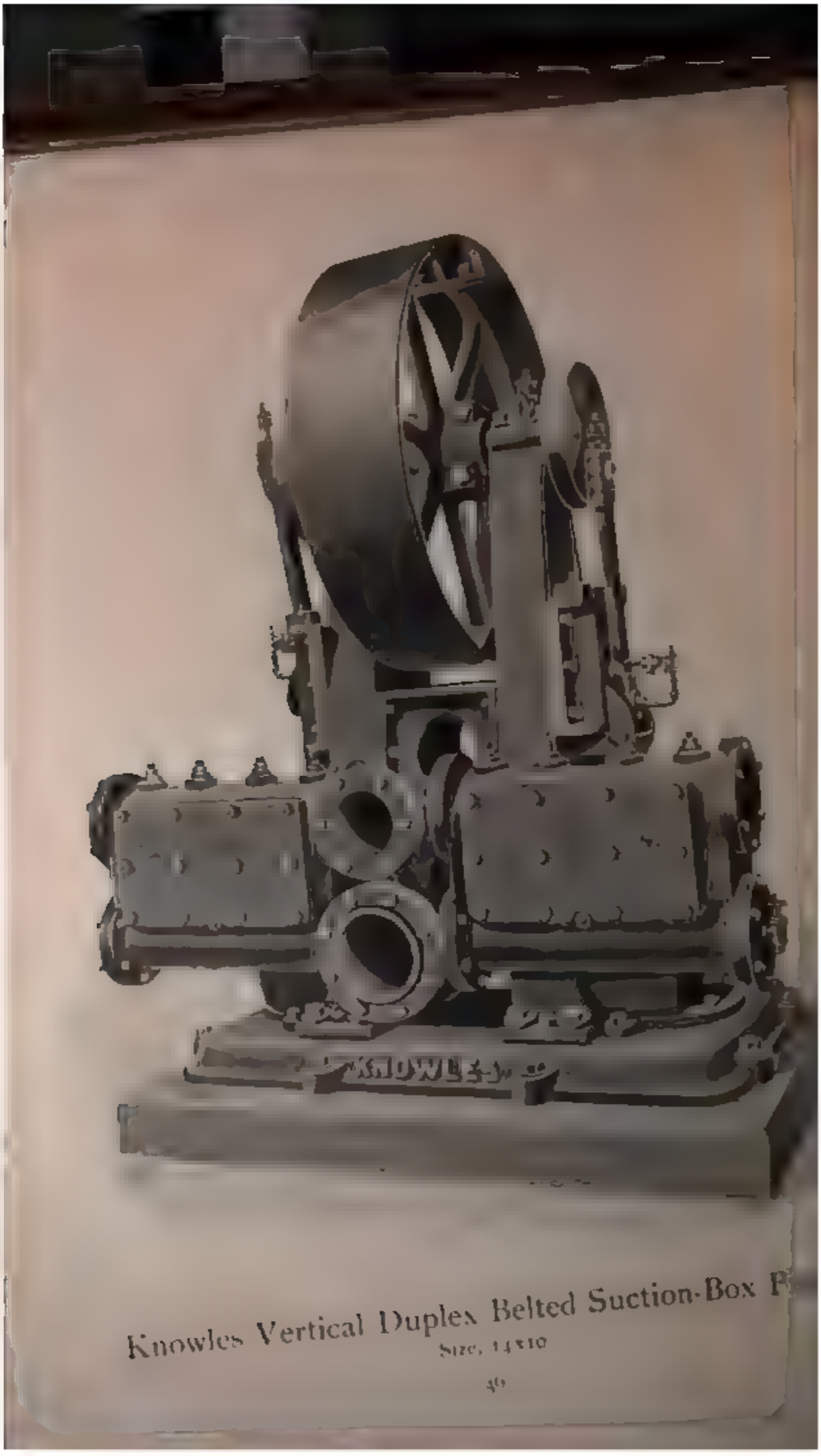
This kind of pump is made geared, as shown in cut on opposite page, or for direct belting.

Give following instructions when inquiring about Suction Pumps:

Range of speeds of paper machine,
Width of paper machine,
Number of suction boxes,
Kind of stock used,
Weights of paper made,
General working conditions.

Sizes and Capacities.

Diameter of Cylinder	Stroke	Revolutions per Minute	Capacity	Suction	Discharge	Pulley		Code Word	
						Diameter	Face	Geared	Belted
18	18	25 to 30	According to Circumstances					Enfamish	Enfever
20	24	20 to 25						Enfeeble	Enfierce
24	24	20 to 25						Enfeoff	Enfilade
26	24	20 to 25						Enfetter	Enfire



Knowles Vertical Duplex Belted Suction-Box P

Size, 14x10

The Knowles Vertical Duplex Belted Suction-Box Pump

Double-acting Pattern. For Paper Machines.

THESE PUMPS are especially adapted for use where little floor space can be obtained, and may be placed in any position relative to the paper machine.

They are made to drive directly with belt, as shown on opposite page, or are supplied with gears, as shown on following page.

The piston rods are of rolled Tobin bronze. Connecting rods are of forged steel with adjustable boxes. Pump is fitted throughout with sight-feed oilers.

Suction and discharge openings are arranged as shown.

Cylinders are lined with composition metal, or special composition gun-metal removable liners will be supplied when desired. The linings regularly furnished can be easily removed and replaced.

The small check valve shown on the right is kept closed unless the vacuum is too high and likely to pull the stuff through the screen; when opened, it admits air to the cylinder and lowers the vacuum; its lift is regulated by an inside spring, adjusted by the hand wheel.

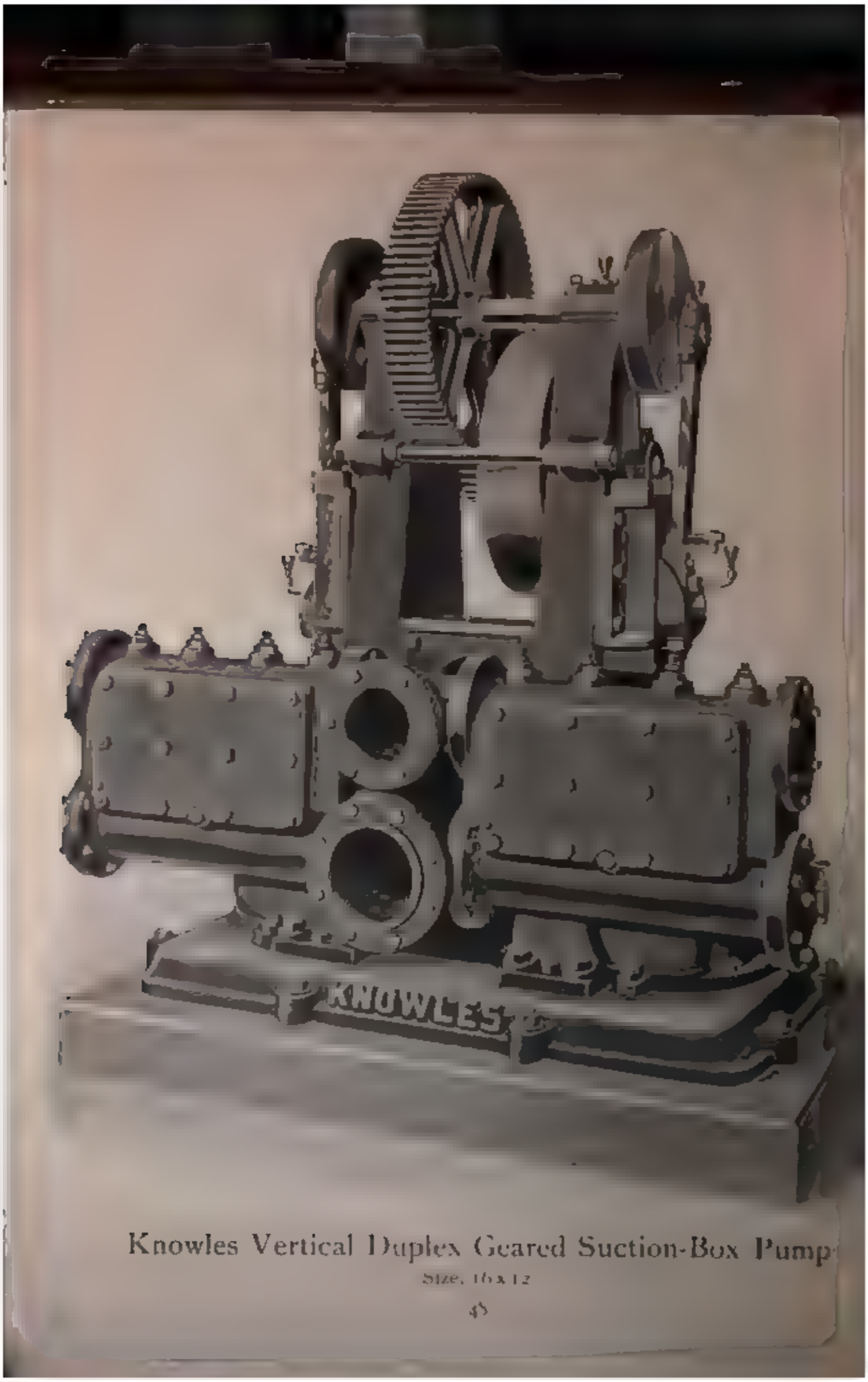
When inquiring about Suction Pumps, always give range of speeds and width of paper machine, number of suction boxes, kind of stock used, weights of paper made, and general working conditions.

Sizes and Capacities.

Diameter of Cylinder	Stroke	Gallons per Revolution	Revolutions per Minute	Gallons per Minute	Suction	Discharge	Pulley Diameter	Pulley Face	Code Word
8	10	8.7	40 to 60	348 to 522	5	4	48	6½	Enforce
10	10	13.6	40 to 60	544 to 816	6	5	48	8½	Enforcing
12	10	19.2	30 to 50	576 to 960	8	6	48	10½	Engage
14	10	26.4	30 to 50	792 to 1320	8	6	48	12½	Engaging
16	12	41.8	30 to 50	1254 to 2090	10	8	66	14½	Engaol
16	16	55.8	35 to 40	1950 to 2228	10	8	72	14½	Engender
18	12	52.9	35 to 40	1850 to 2115	12	10	72	14½	Engild
18	16	70.5	30 to 35	2115 to 2468	12	10	84	16½	Englad
18	18	79.4	30 to 35	2378 to 2776	12	10	84	16½	Engloom

We also make combination pumps, where one cylinder works on wire suction boxes d the other on felt suction boxes; and in such special cases we invite correspondence, order to enable us to offer the best possible type of machine to meet the conditions isting.

We manufacture also Triplex Vertical Bucket Suction Box Pumps of special terns. See page 51.



Knowles Vertical Duplex Geared Suction-Box Pump

Size, 16 x 12

The Knowles Vertical Duplex Geared Suction-Box Pump

Double-acting Pattern. For Paper Machines.

THE CUT on opposite page shows our Duplex Geared Suction Box Pump. For fast running paper machines and high speed shafting, the geared pump has a distinct advantage over the belted pump, since in the latter the severe strain on the belt soon wears it out.

Pumps have large valve area, and valves easily accessible. Cylinders are of the double acting pattern, lined with composition metal; or removable liners of special cast composition gun-metal are furnished when desired.

The following table gives sizes, capacities, etc. The capacities figured at these speeds can be increased if necessary.

Whenever required, we send prints with location of foundation bolts, principal dimensions, etc., on receipt of order, so that no unnecessary delay may occur in setting up.

Always give following data when inquiring about suction pumps:

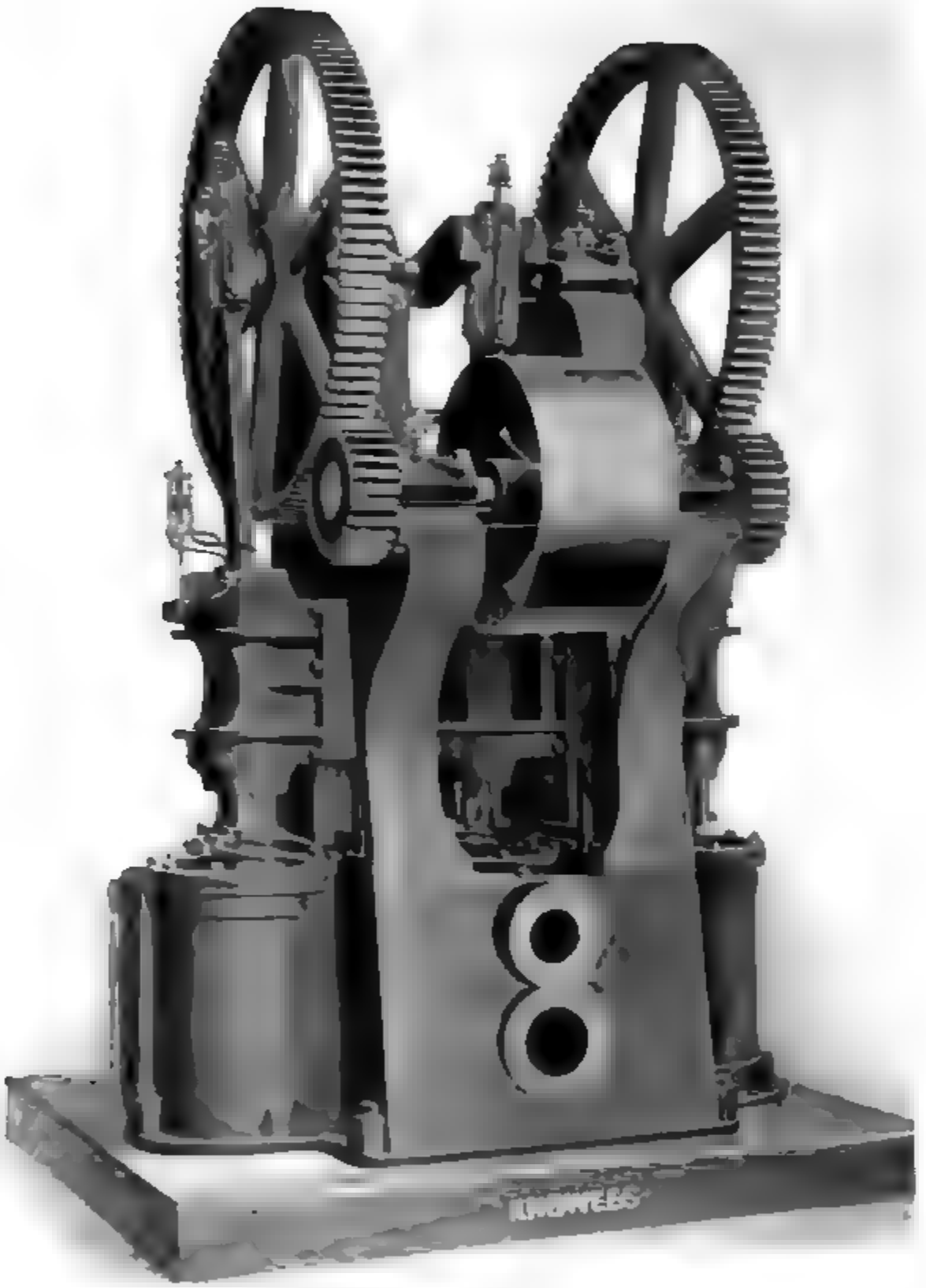
Range of speeds and width of paper machine, number of suction boxes, kinds of stock used, weights of paper made, and general working conditions.

Sizes and Capacities.

Diameter of Cylinder	Stroke	Gallons per Revolution	Revolutions per Minute	Gallons per Minute	Suction	Discharge	Pulley Diameter	Pulley Face	Ratio of Gears	Code Word
8	10	8.7	40 to 60	348 to 522	5	4	30	6½	3½ to 1	Englut
10	10	13.6	40 to 60	544 to 816			30	6½	3½ to 1	Engorge
12	10	19.2	30 to 50	576 to 960	7	5	30	8½	3½ to 1	Engrail
14	10	26.4	30 to 50	792 to 1320	8	6	30	8½	3½ to 1	Engrasp
16	12	41.8	30 to 50	1254 to 2090	0	8	40	8½	4 to 1	Engrave
16	16	55.8	35 to 40	1954 to 2228	0	8	40	8½	4 to 1	Engreve
18	12	52.9	35 to 40	1850 to 2115		0	48	8½	4 to 1	Engross
18	16	70.5	30 to 35	2115 to 2468	2	0	48	8½	4 to 1	Enguard
18	18	79.4	30 to 35	2378 to 2776	2	0	48	8½	4 to 1	Engulf

We also make combination pumps, where one cylinder works on wire suction boxes and the other on felt suction boxes; and in such special cases we invite correspondence, in order to enable us to offer the best possible type of machine to meet the conditions existing.

We manufacture also Triplex Vertical Bucket Suction-Box Pumps of special patterns. See page 51.



The Knowles Vertical Triplex Suction-Box Pump

Geared

Size, 15 x 18

The Knowles Vertical Triplex Suction-Box Pump

Geared.

SUCTION IS now becoming one of the principal features in paper making. This is due to the increasing speed of paper machines, requiring more suction-boxes and larger pumps, with greater suction power.

Our Vertical Triplex, Single Acting Suction Box Pumps meet all these requirements, and are suitable for the widest and fastest machines. On the opposite page we show a cut of one of these pumps. These machines are vastly superior to any others in the market for this line of work. This is a new design, embodying particular advantages for suction work, and this line of pumps is built especially for those purchasers requiring the very best and "highest grade" machine obtainable.

It is impossible to give details in regard to suction box work here. We invite correspondence for each particular case, and will be pleased to give all necessary information regarding materials, construction, design, and service guaranteed.

Sizes smaller than 18 x 18 are made with one spur gear and pinion between the frames, similar to cut on page 48, with the same style cranks and connecting rods as there shown.

Sizes, Capacities, Etc.

Diameter of Cylinder	Length of Stroke	Gallons per Revolution	Revolutions per Minute	Gallons per Minute	Suction	Discharge	Pulley		Gears	Code Word
							Diameter	Face		
14	12	23.9	30 to 40	717 to 956	8	6	30	8	4 to 1	Eristic
16	12	31.3	30 to 40	939 to 1252	10	8	30	10	4 to 1	Ermine
16	16	41.7	30 to 40	1250 to 1670	10	8	30	12	4 to 1	Erminette
18	12	39.6	30 to 40	1188 to 1584	12	10	30	15	4 to 1	Ermitage
18	18	59.5	30 to 40	1780 to 2380	12	10	30	15	4 to 1	Erode

Knowles Vertical Triplex Power Vacu

For Sulphite Process

Size, 15 x 18

5?

The Knowles Vertical Triplex Power Vacuum Pump

For Sulphite Process.

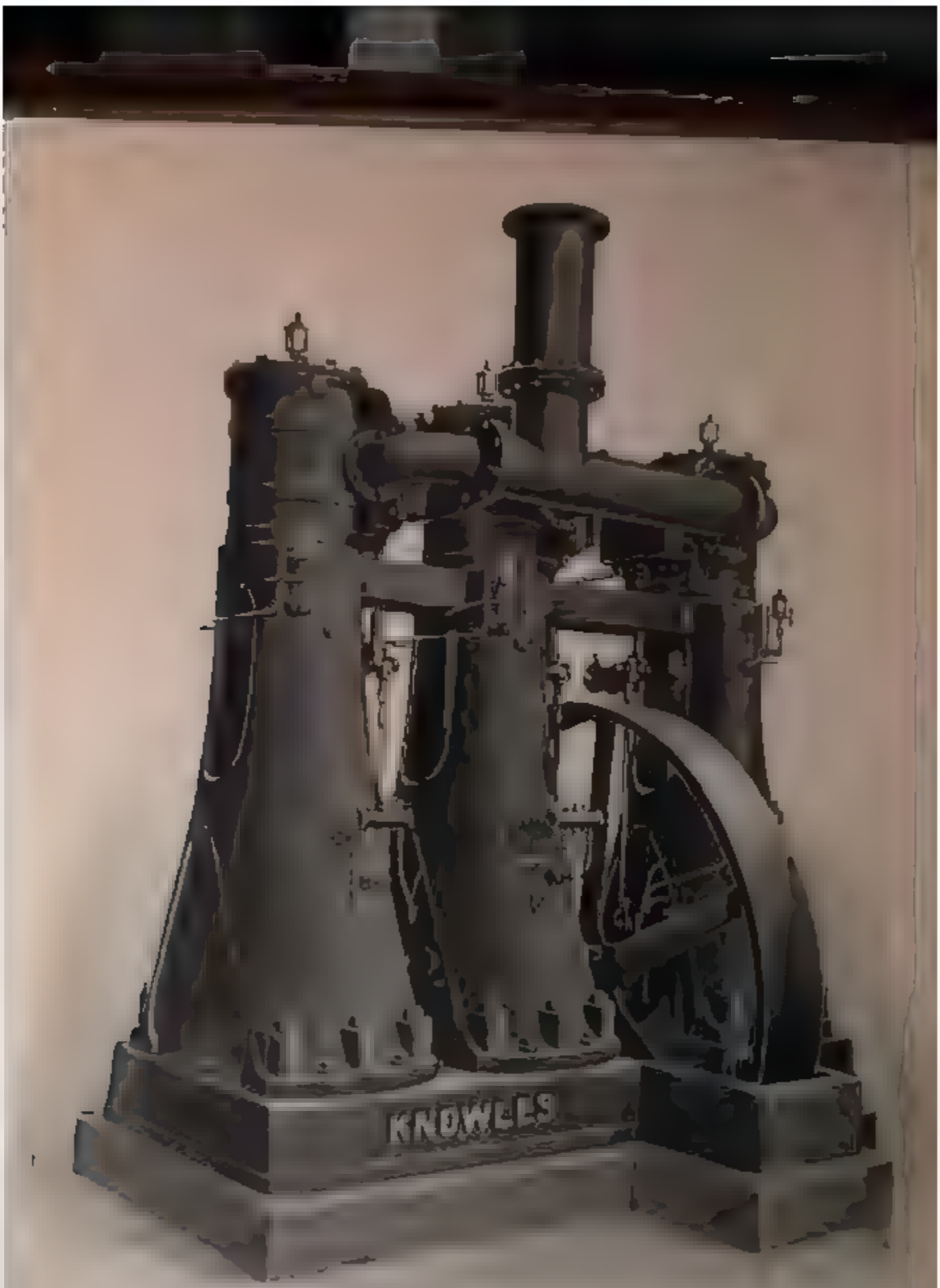
THIS MACHINE is particularly adapted for pumping sulphur fumes in sulphite mills, although it may be used as well for general work where a high vacuum is necessary, or even for the purposes of an air compressor for 25 or 30 pounds air pressure.

The cylinders and running parts in contact with the sulphur fumes are made of composition. The valves are of the plain slide valve type, especially adapted to this kind of service, and are moved from eccentrics on the main shaft as in ordinary steam engines. The main shaft runs in large bearings, lined with hard, bored babbitt, and has its crank pins set at angles of 120°. The connecting rods have adjustable boxes of the locomotive type, and are specially designed for this class of engine. The crossheads are of high class engine type, made adjustable for wear, and are guided in long and broad ways cast on the main frames of the machine. The driving pulley is within the bed frame, which, in fact, contains all the parts of the engine, making a solid, compact and self-contained machine. All the wearing parts are of ample size, and, where necessary, are fitted with conveniently manipulated adjustments, while an ingenious system of oil cups and piping insures a proper oil supply to these parts at all times.

This machine is designed to run at from 30 to 50 revolutions per minute, and is of first-class construction throughout. It is novel, and its successful application to this particular kind of bleachery work makes it a noteworthy machine.

Sizes and Capacities.

Diameter of Cylinder	Stroke	Revolutions per Minute	Cubic Feet Free Air per Minute	Tons of Sulphite in 24 Hours	Code Word
14	10	50	240	8 to 10	Enhance
16	12	50	300	12 to 15	Enharbor
18	18	40	600	18 to 22	Enharden
20	18	40	750	20 to 25	Enigma
24	18	40	1125	30 to 35	Enjoin
24	24	30	1125	35 to 40	Enjoy
28	24	30	1500	40 to 50	Enjoyer



Knowles Vertical Power Vacuum Pump

For Sulphate Process

Size, 18 x 18

[redacted]

The Knowles Vertical Duplex Power Vacuum Pump

For Sulphite Process.

THE CUT on opposite page shows another view of the Vertical Triplex Vacuum Pump for Sulphite Process described on the two preceding pages.

These pumps are also made duplex by leaving off one cylinder and its foundation—that is, by cutting off the left hand third in the opposite cut.

The Duplex Vacuum Pumps are made both geared and direct belted.

Sizes and Capacities.

Diameter of Cylinder	Stroke	Revolutions per Minute	Cubic Feet Free Air per Minute	Tons of Sulphite in 24 Hours	Code Word	
					Belted	Geared
14	10	50	160	5 to 8	Eroding	Errhine
16	12	50	260	8 to 10	Erosion	Erring
18	18	40	400	12 to 15	Erosive	Errorist
20	18	40	500	15 to 20	Erotic	Erudite
24	18	40	750	20 to 25	Errable	Erupt
24	24	30	750	25 to 30	Erratic	Eruption
28	24	30	1000	30 to 35	Erratum	Eruptive

The Knowles Vertical Single Power Vacuum Pump

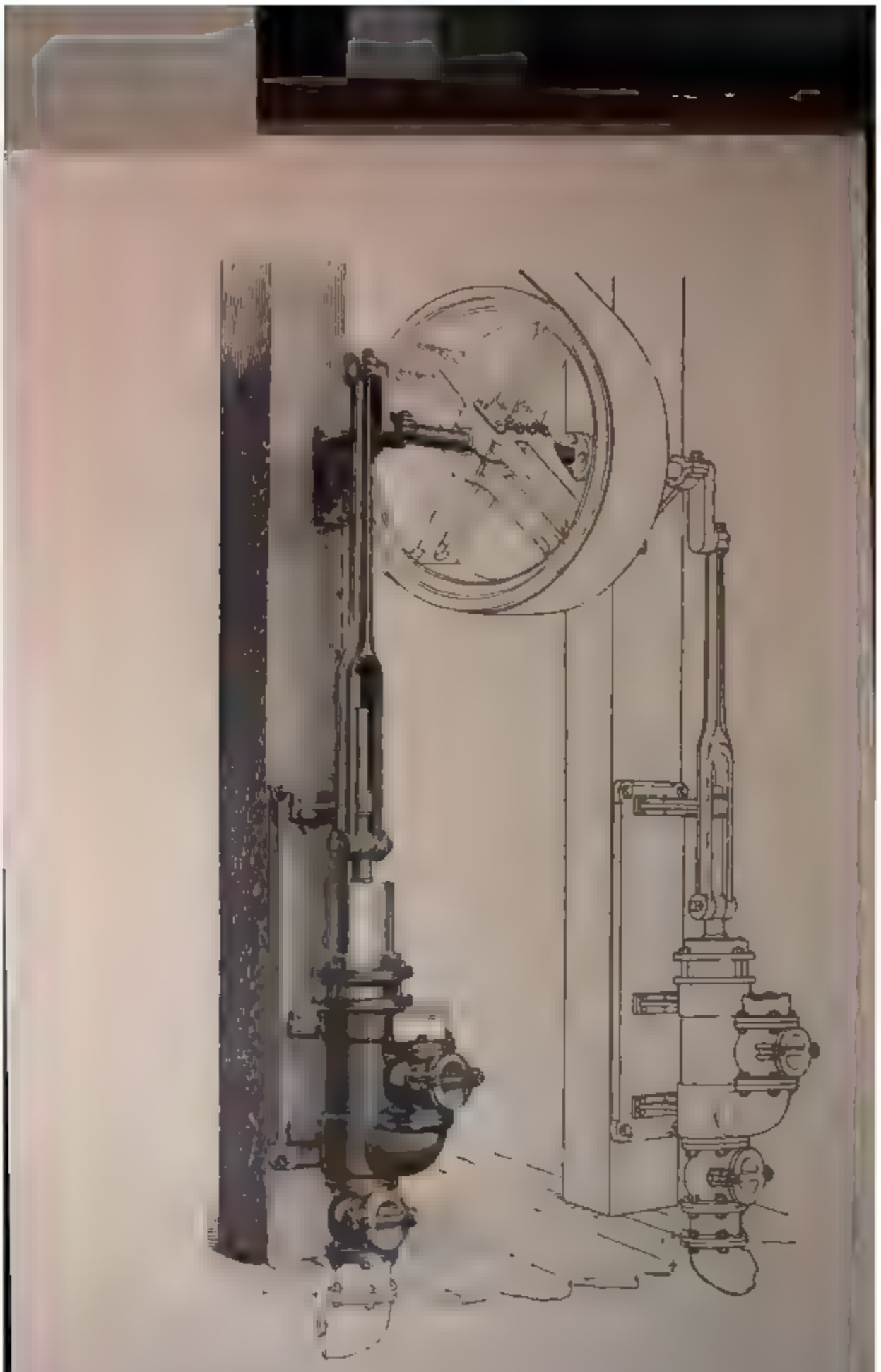
For Sulphite Process.

WE ALSO make a single cylinder pump of the same pattern. The general style of this machine is the same as shown in the cut on the opposite page, but leaving off the two left hand cylinders and their foundations and replacing the foundation of central cylinder by an out-board bearing.

Sizes and Capacities.

Diameter of Cylinder	Stroke	Revolutions per Minute	Cubic Feet Free Air per Minute	Code Word Belted
14	10	50	80	Enjoying
16	12	50	130	Enkindle
18	18	40	200	Enlard
20	18	40	250	Enlight
24	18	40	375	Enlink
24	24	30	375	Enlist
28	24	30	500	Enlisted

We build Horizontal Pumps for the same work and of the same sizes as above.



Knowles Vertical Post Stuff Pump

The Knowles Vertical Post Stuff Pump

WE PRESENT an illustration on opposite page of a stuff pump that will be recognized throughout the paper trade. This pump has grown into favor, owing to its absolute simplicity, its durability, and small first cost. There is scarcely a paper mill that is not fitted with one or more of these pumps, delivering paper stuff to some machine, passing or elevating it to or from a vat, or connected up for some similar duty.

The pumps are arranged generally in gangs, as here shown, and are bolted to vertical posts with a common shaft between. We furnish that part of the pump shown in shaded lines including *bearing*, *pitman*, *crank*, and *five feet of shaft*.

As all pumps should be completely *brass mounted*, owing to the chemicals used in the preparation of the stuff, we make the following parts of the best composition gun-metal: *plunger*, *gland*, *lining of cylinder*, *valve*, *valve seat*, and, for a small additional cost, *the entire valve chamber*. The valve chamber covers may be removed each by loosening two nuts and by disengaging the swing bolts. The *ball valves* are known to be the most efficient when pumping paper stock, as they have less tendency to restrict the passages. These valves are made of composition metal or vulcanized rubber.

Sizes and Capacities.

Table Refers to one Pump only.

Diameter of Plunger	Stroke	Revolutions per Minute	Capacity, in Tons, of Dry Paper in 24 Hours	Suction	Discharge	Code Word
6	6	40 to 50	4 to 5	4	4	Enliven
6	12	25 to 30	4 to 6	5	5	Enmarble
7	12	25 to 30	5 to 8	6	6	Enmesh
8	12	25 to 30	7 to 10	6	6	Enmity
8	16	25 to 30	9 to 13	8	8	Enmossed
10	16	25 to 30	15 to 21	10	10	Ennoble

We also manufacture a special stuff pump, having a three-lip rubber inlet and outlet valve. This valve is also made with two lips, to admit of the passage of large pieces.

These special valves are suitable for a pump handling heavy stock. They are made of selected material, and are substituted in place of the ordinary brass ball valves described above. Pumps so arranged may be used for pumping acids, chemicals, dyes, or other corrosive liquids; and when intended for such work, the cylinder barrels may be made of glass, mounted in composition suction and discharge connections; or the pump may be so constructed that all parts in contact with the liquid to be handled are of lead or cast iron, depending on the character of the liquid. The material pumped passes through in the most direct manner possible. This machine cannot fail to interest, combining as it does absolute simplicity, durability, and moderate first cost. There is hardly a paper mill that can afford to be without such a pump. They are made in various sizes, of capacities up to 40 tons of dry paper in 24 hours. We invite correspondence, with full particulars regarding service required.

Knowles Vertical Fly-wheel Stuff Pump

(Can be made Single or Duplex)

Size, 6 x 12

The Knowles Vertical Fly-wheel Stuff Pump

Single or Duplex.

FOR PLACES where a pump with band fly wheel is required, we build the single or duplex pump, whichever is preferred, and the cut on the opposite page illustrates the former pattern.

The pump is constructed with extra large area of base to give stability and to distribute the weight for setting on an ordinary floor. All wearing parts are adjustable, and the frame is made strong on account of height.

The brass mounting of this pump corresponds to that of the pump described on page 57.

Sizes and Capacities.

Table refers to Single pump shown in illustration.

Diameter of Plunger	Stroke	Capacity, in Tons, of Dry Paper, in 24 Hours	Suction	Discharge	Pulley		Code Word
					Diameter	Face	
5	12	3 to 6	5	5	40	5	Ennui
6	12	4 to 8	5	5	40	5	Enode

Also patterns for other sizes.

The Knowles Vertical Fly-wheel Post Stuff Pump

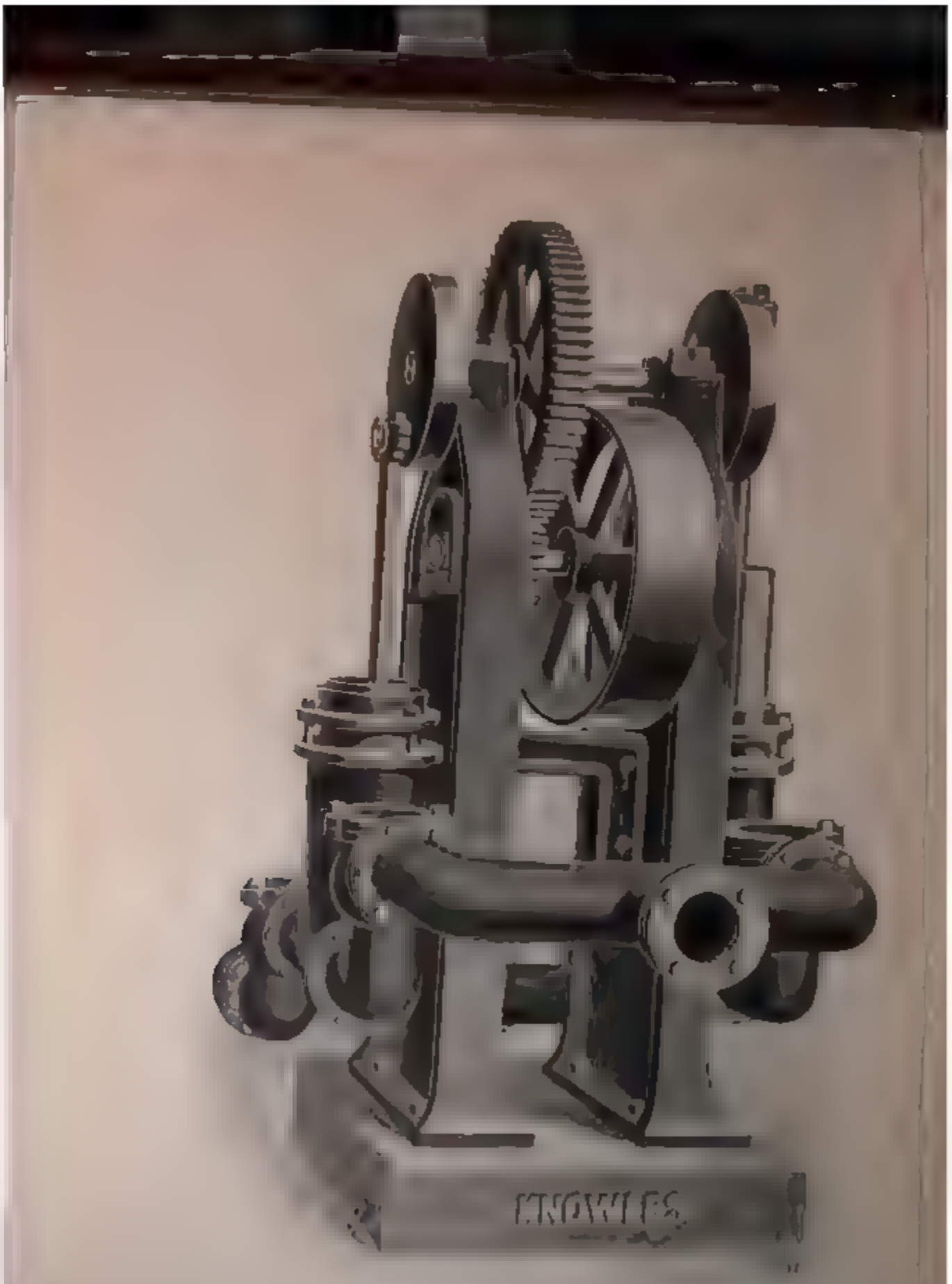
Piston Pattern.

IT IS convenient sometimes to have a fly-wheel stuff pump bolted to a post and to dispense with the base to save floor space. For such instances we have an especially designed frame, using a fly-wheel similar to that in illustration, but with pump cylinder made piston pattern.

All our stuff pumps are brass mounted, fitted with ball valves, and are designed to give quick access to internal parts.

Sizes and Capacities.

Diameter of Piston	Stroke	Capacity, in Tons, of Dry Paper in 24 Hours	Suction	Discharge	Pulley		Code Word
					Diameter	Face	
4	6	2 to 3	3	3	16	3½	Enoding
5	6	3 to 4	3½	3½	24	3½	Enomoty
6	6	4 to 5	4	4	24	3½	Enormous



Knowles Vertical Duplex Geared Stuff Pump

Size, 10 x 12

The Knowles Vertical Duplex Geared Stuff Pump

ANOTHER DESIGN of stuff pump is recommended where more than ordinary power is required, where the speed of the line shaft is greater than usual, or where it is desirable to gain power by belting-down. For this reason we have interposed gearing and built the pump cylinders on opposite sides of one frame, with a common suction opening in rear and discharge opening in front.

Like all our stuff pumps, this design has ball valves, and all parts that come in contact with the stuff are made of non-corrosive metal.

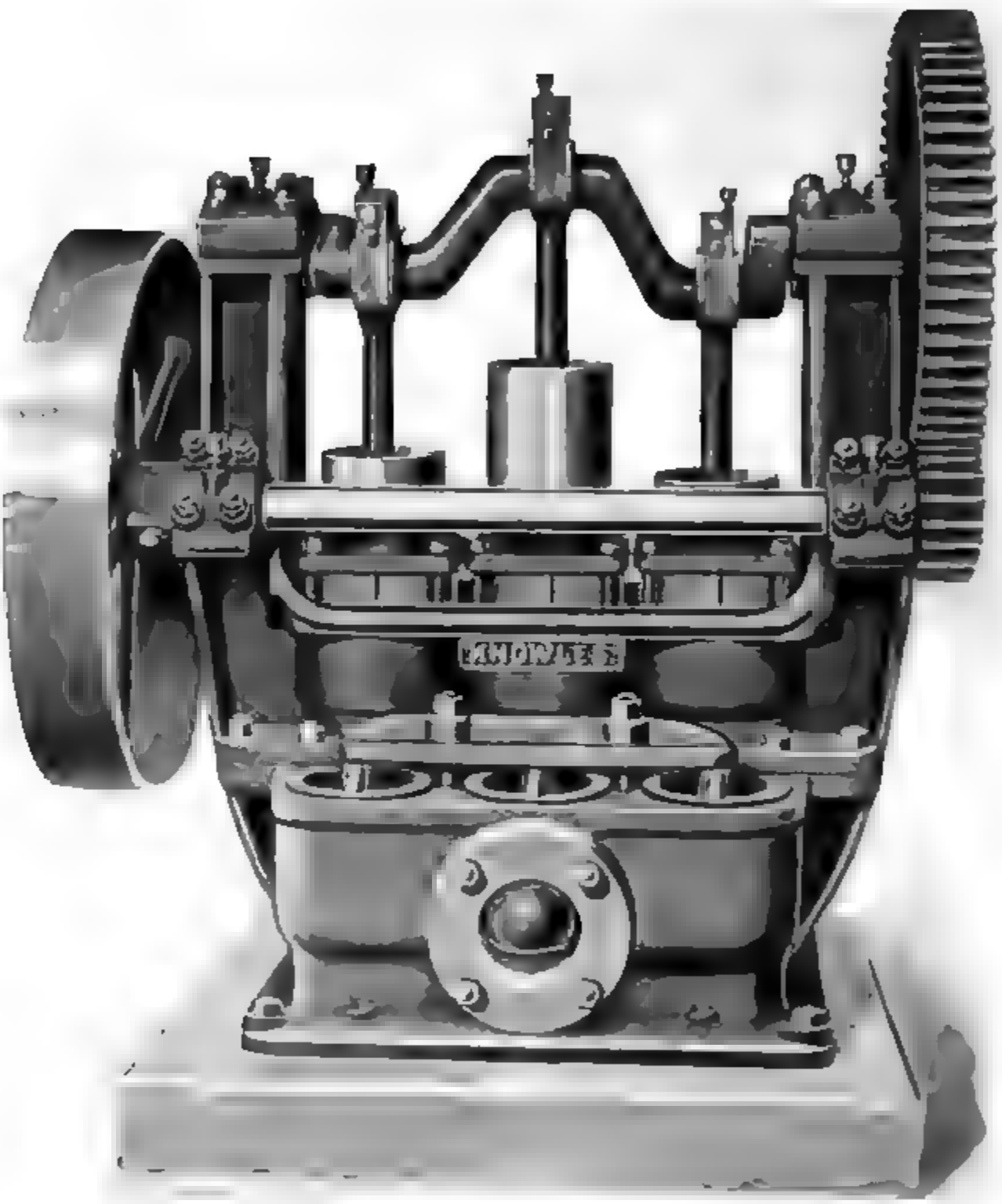
The speed of the pulley may be calculated easily from the ratio of gears and the revolutions of the pump given in the table.

This pump is strong and substantial, and with proper care should last many years and give complete satisfaction.

Sizes and Capacities.

Diameter of Plunger	Stroke	Revolutions per Minute	Capacity, in Tons, of Dry Paper, in 24 Hours	Suction	Discharge	Pulley		Ratio of Gears	Code Word
						Diameter	Face		
5	12	25 to 30	4 to 8	4	4	24	6½	4 to 1	Enrage
6	12	25 to 30	6 to 12	4	4	24	6½	4 to 1	Enraging
7	12	25 to 30	10 to 15	5	5	28	8½	4 to 1	Enrank
8	12	25 to 30	12 to 18	5	5	28	8½	4 to 1	Enrapt
10	12	25 to 30	18 to 27	6	6	36	8½	4 to 1	Enravish
12	12	25 to 30	27 to 40	8	8	42	8½	4 to 1	Enrheum

One special feature of all our stuff pumps is the design of valve, with removable seat and cage, which allows the proper lift of valve by dislodging any solid matter that would be likely to hold the valve down.



Knowles Vertical Triplex Stuff Pump

Size, 7 x 8

The Knowles Vertical Triplex Stuff Pump

AMONG THE advantages of this stuff pump are:

Small floor space,
Increase of power by gearing,
Facility of examination of valves,
Adjustable wearing parts,
Composition fittings;

and it has in addition large valve area and an even action on account of its three plungers.

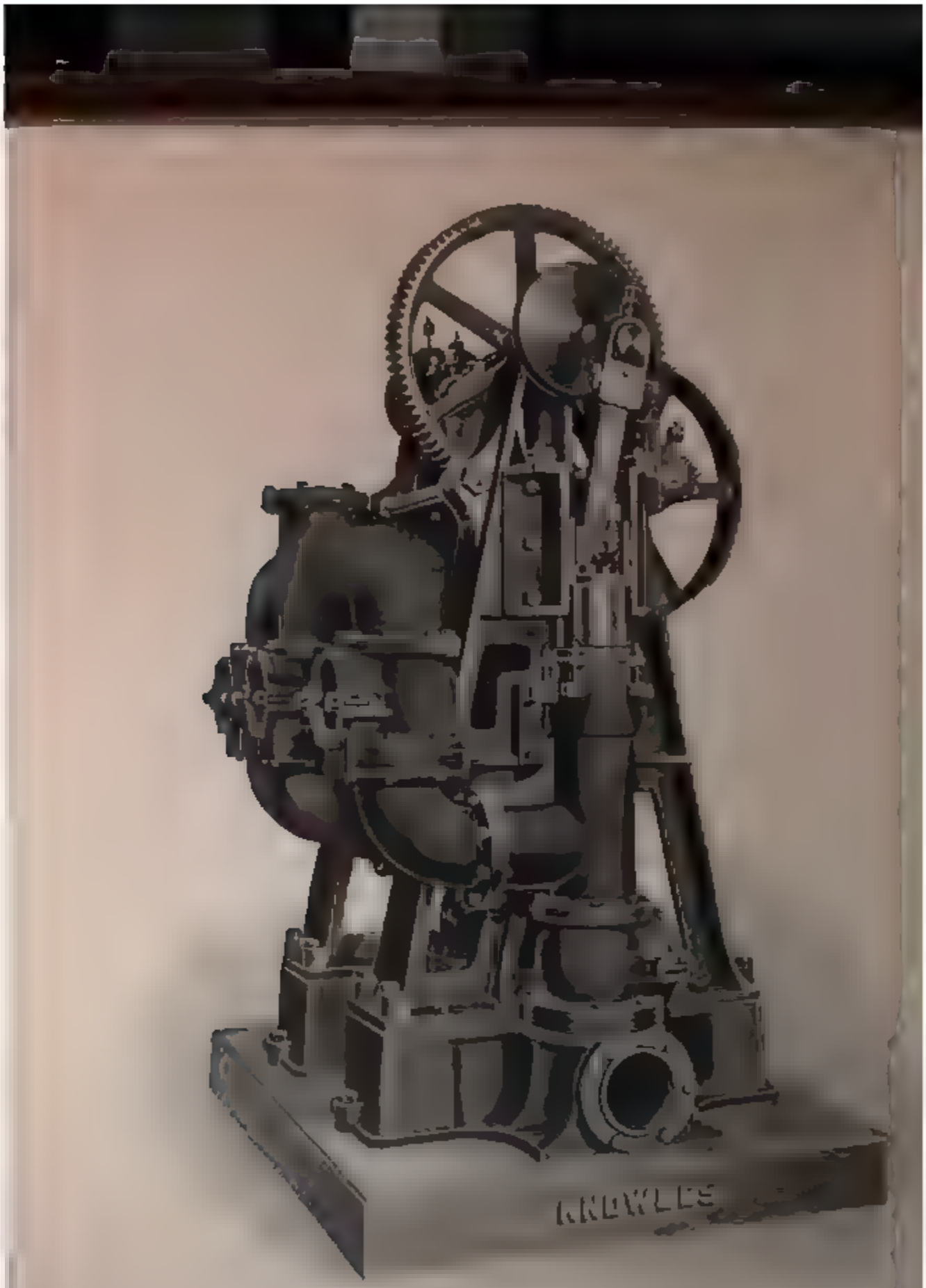
It is evident at a glance that this pump is compact and complete. In detail the parts are well constructed, the bearings lined with babbitt metal, hammered and bored-out to an exact fit on the shaft. Each connecting rod has its lower end fitted with a composition ring bushing, and is held in the plunger or trunk by a steel pin. The upper end works on the shaft with adjustable boxes.

There are three valves for suction and three for discharge, each having an independent cover and knife-edge cage. The following is a list of composition metal fittings: *plungers, glands, throats or linings in cylinders* for each plunger; *valves, valve seats, boxes* on connecting rods; *ring bushings*, in lower end of connecting rods.

Sizes, Capacities, and Dimensions.

Diameter of Plungers	Stroke	Revolutions per Minute	Capacity, in Tons, of Dry Paper, in 24 Hours	Suction	Discharge	Pulley		Ratio of Gears	Dimensions over all			Code Word
						Diameter	Face		Length	Width	Height	
4	4	40	2 to 5	3	3	20	3	5 to 1	32½	32½	31	Enrich
4	6	35	3 to 6	3	3	20	3	4 to 1	32½	32½	31	Enridge
5	8	35	4 to 8	4	4	20	4	4 to 1	40¼	38	41	Enring
7	8	35	8 to 15	5	5	30	5	4¼ to 1	51	43	55	Enripen
8	8	35	12 to 18	6	6	30	6	5 to 1	59	43	57½	Enrive
8	10	35	15 to 22	6	6	36	6	5 to 1	59	43	57½	Enrobe
8	12	30	16 to 23	6	6	36	6	5 to 1	67	48	(9)	Enrobing

Valves are made of composition metal or vulcanized rubber as preferred.



Knowles Vertical Triplex Geared Stuff Pump

"High Grade" Pattern

Size, 8 x 10

64

The Knowles Vertical Triplex Geared Stuff Pump

"High Grade" Pattern.

OUR IMPROVED "High Grade" Triplex Stuff Pump receives the prompt indorsement of every paper maker who investigates it, owing to the general excellence of the design in all its details. This has led to its adoption as a standard pump in the largest and most prominent paper mills in this country, where it is desired to secure a thoroughly first class machine, combining the best principles of machine design with superior mechanical construction. It draughts and delivers the stock in an unvarying and continuous flow, and its work on Fourdrinier machines contributes to produce a uniform weight of paper. When it supplies refining engines, it produces the most uniform fiber, and can be run without pumping a needless surplus. The largest sizes up to 40 and 50 tons are extensively used in fiber and paper mills for moving pulp in large quantities; and where the paper mill is separated from the pulp mill will deliver the pulp through long lines of pipe. Pumps in the list below are suited for pressures not exceeding 50 pounds per square inch.

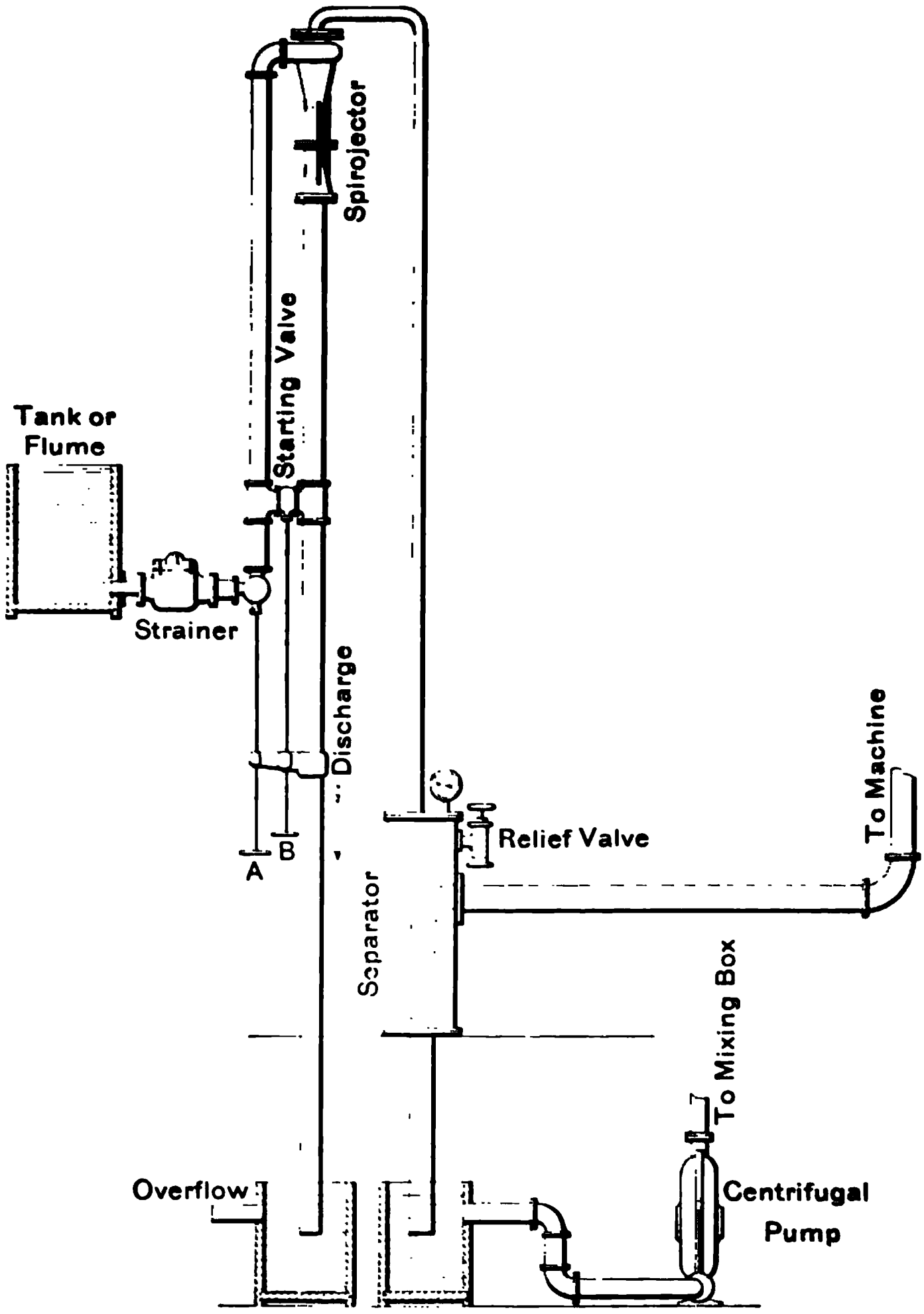
These pumps are self contained, each with a firm bed plate for foundation. The valves are bronze balls, with proper lift and weight as required, and with independent bronze seats, all specially designed with a view to accessibility for repair, and uniform flow with least resistance to the stuff. Pump cylinders and glands are of extra length, and lined with bronze. Plungers are of bronze and water sealed. All passages are made with easy bends, and rounded so as to scour clear, avoiding any corners affording an opportunity for the formation of slugs. Connecting rods are of proper length (from four to six times the length of the crank) and are provided with bronze bushed bearings, with adjustments for the boxes. The crank shaft is of forged steel, and runs in extra long, well babbitted bearings. Sight feed oilers are provided, cut gears are used, and pulleys specially made and balanced. Pipe flanges are furnished, and are regularly threaded for standard wrought iron pipe, but, when required, will be fitted for copper pipe connections. The pump barrels for ordinary work are iron, and, when required, can be made of composition. Cross-heads are fitted with adjustable shoes when desired. The regular cross-head adjustment is furnished unless otherwise stated, and is provided for in the slides, which are movable sideways.

These pumps are also built direct belted in all sizes, substituting in place of gears and pulleys one large driving pulley, made in halves and mounted on crank shaft. The main gear in the geared pump can be made in halves, if desired. The geared pumps are more applicable to high speed shafting.

These pumps are made for ordinary service found in paper mills, and we also make pumps for heavy work for pumping stock up to 150 pounds pressure. Special correspondence is invited.

Sizes, Capacities, and Dimensions.

Diameter of Cylinder	Stroke	Suction	Discharge	Pulley		Ratio of Gears	Dimensions over all			Capacity, in Tons, of Dry Paper in 24 Hours	Code Word
				Diameter	Face		Length	Width	Height		
5	8	4	4	20	4	5 to 1	47 1/8	35	55 3/4	5 to 9	Enroll
6	6	4	4	20	4	5 to 1	47 1/4	35	55 3/4	6 to 10	Enroot
6	8	4	4	20	4	5 to 1	47 1/4	35	55 3/4	8 to 13	Ensate
7	8	7	7	30	5	4 1/4 to 1	73	64	91	10 to 15	Ensconce
8	8	8	8	30	6	5 to 1	73	64	94	12 to 20	Enseal
8	10	8	8	36	6	5 to 1	77	66	111	18 to 25	Ensearch
9	10	8	8	36	6 1/2	5 to 1	77	66	111	25 to 35	Ensemble
10	10	10	10	36	6 1/2	5 to 1	77	66	111	35 to 45	Enshield
11	12	10	10	42	8 1/2	5 to 1	90	78	122	40 to 50	Enshrine
12	12	12	10	48	8 1/2	5 to 1	98	83	128	50 to 60	Enshroud
13	12	12	10	48	8 1/2	5 to 1	98	83	128	60 to 70	Ensiform



The Knowles Suction-Box Syphoning Apparatus

The Knowles Suction-Box Syphoning Apparatus

As Applied to Fourdrinier Machines.

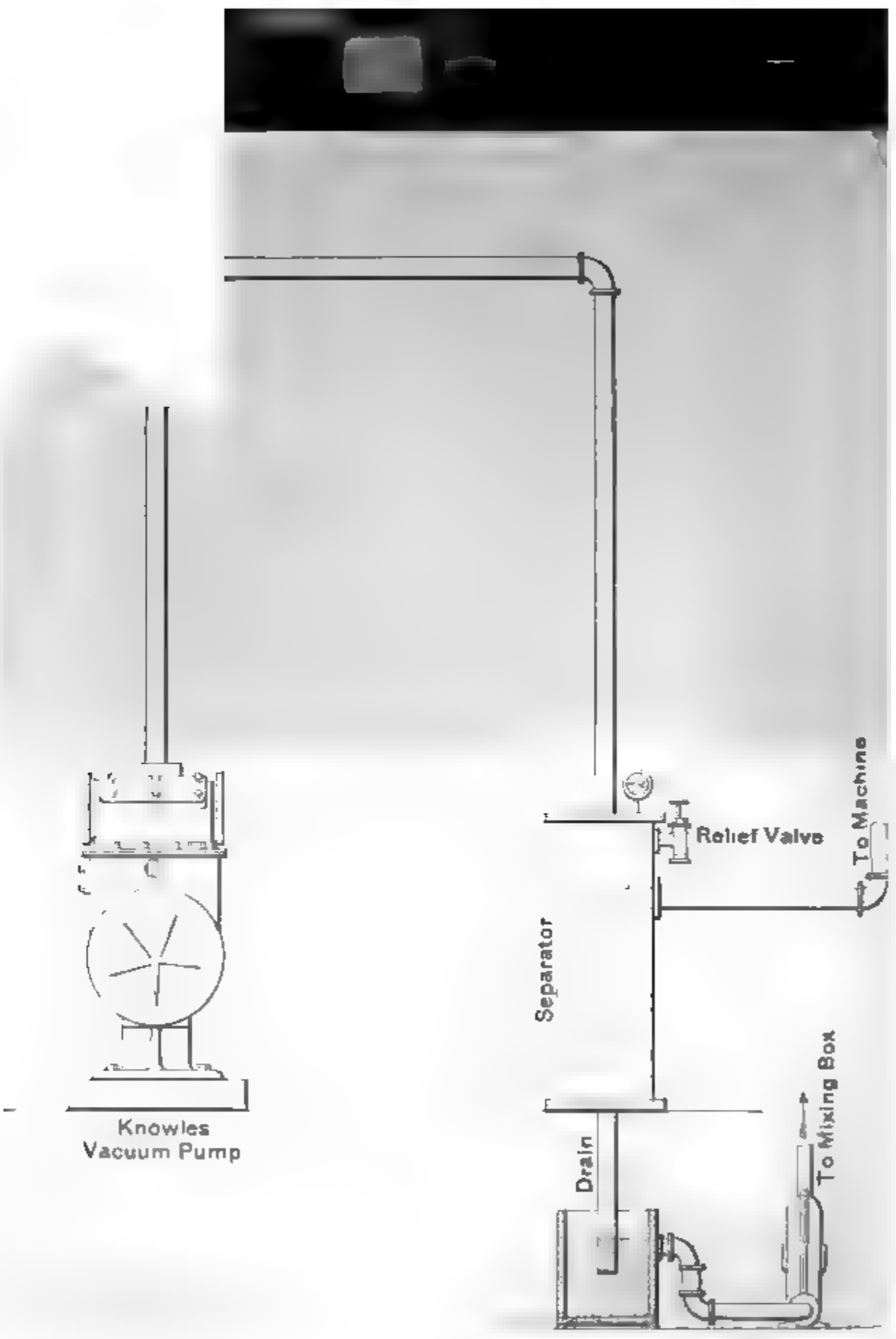
THE "SPIROJECTORS," shown later, are also suitable for producing vacuum in suction boxes of paper machines, and are so used with machines having either wire or felt screens. Where available water power is found, the use of this apparatus allows the vacuum pump to be entirely dispensed with. The cut opposite shows the water supply on the left, consisting of a tank, or flume. From this the water flows through a strainer and up to the Spirojector. The water is here given a spiral course as it goes through, and this gives a good vacuum in the small pipe above, which connects with the Separator as shown. From the Separator (which is about four feet high and eighteen inches in diameter) a four inch pipe leads to the suction boxes of the Fourdrinier machine. This pipe on entering the Separator is turned down, so that the water coming from the machine will remain in the Separator, and be expelled through the drain pipe provided. This drain pipe, as well as the draft tube, should be sealed in water at all times, to retain the vacuum. The length of draft tube should be the number of feet fall at flume. The small relief valve on the Separator is kept closed unless the vacuum is too high and likely to pull the stuff through the screen. When opened, it admits air to the Separator and lowers the vacuum. Its lift is regulated by an inside spring, adjusted by the hand wheel. The connection between the supply and discharge pipe, marked "starting valve," can be used when the water is too low to allow the use of the high lift; otherwise, this is closed. The water from the suction boxes can be returned to the mixing boxes by a small centrifugal pump. The supply water for the syphon is piped away through the overflow.

To start the vacuum, open valves A and B, and in a few minutes close B.

The apparatus throughout is made of sufficient capacity to work all the boxes on any wide, fast running machine.

Our strainer, shown in cut, is very easily cleaned.

The next page shows the arrangement where a vacuum pump is indispensable.



The Knowles Vacuum Pump

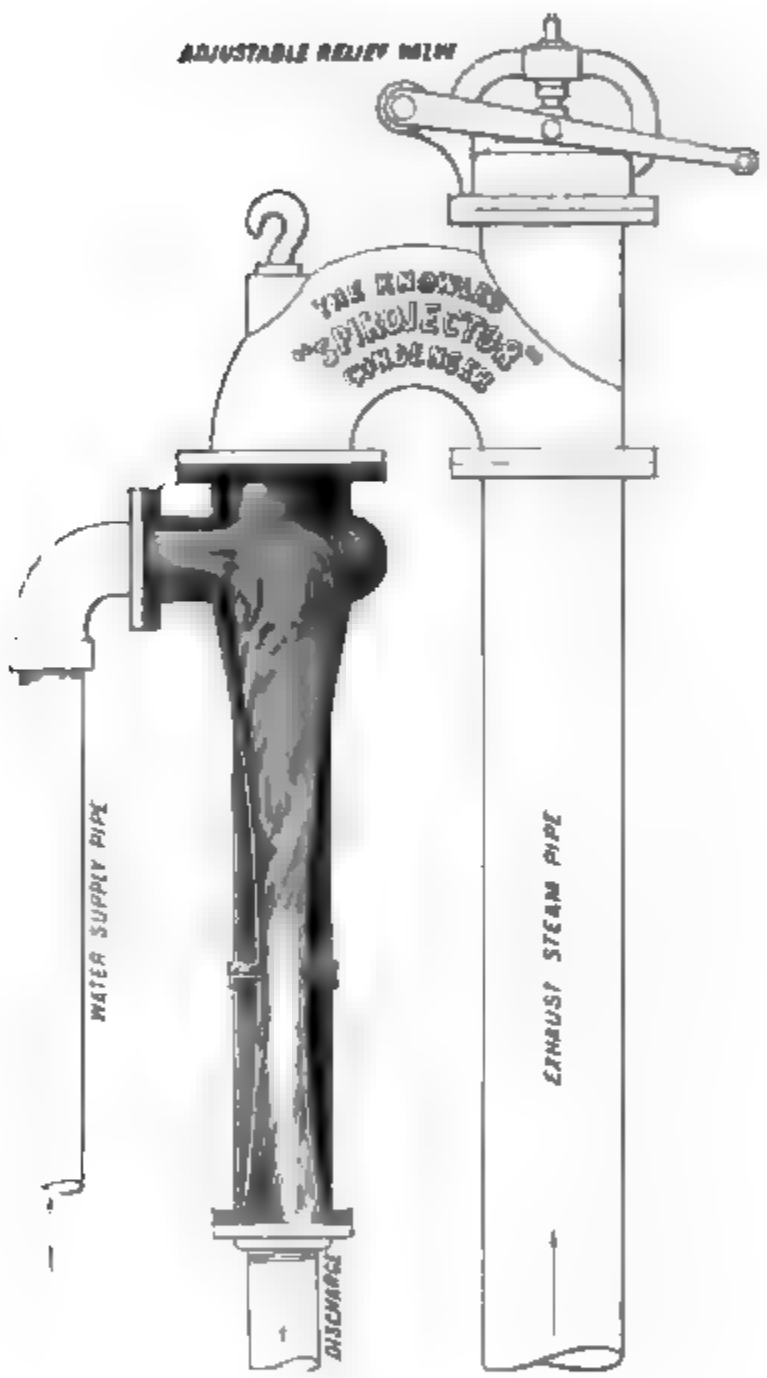
Arranged with Separator

The Knowles Separator and Vacuum Pump

For Suction-Boxes of Fourdrinier Machines.

WE SHOW in the opposite diagram how a much smaller Vacuum Pump than is generally used can produce the required vacuum on the suction boxes of Fourdrinier machine. This is brought about by the manner of piping and use of a Separator.

The suction pipe leads from the Knowles "Close Clearance" Suction-Box Pump to a height of eight or ten feet, over and down to a Separator resting on the floor back of the Fourdrinier machine. A four inch pipe leads from the Suction-Boxes to this Separator, and is directed downward after entering the latter. The water and air are pumped from the Suction-Boxes, but the water is retained by the Separator, and drains off through the pipe shown at bottom. This pipe should be sealed as shown. In this manner the Separator takes care of the water, and the Vacuum Pump has to take care of nothing but the air which accumulates, and thus allows a much smaller pump to be used. A small relief valve shown on Separator is kept closed unless vacuum is too high and likely to pull the stuff through the screen; when opened, it admits air to the Separator and lowers the vacuum. Its lift is regulated by an inside spring, adjusted by the hand wheel. The Suction-Box Pump is fitted with an ordinary priming pipe. The water so supplied is used for sealing the pistons and valves, and is discharged as usual from the pump. A vacuum gauge is provided, and placed on top of the Separator. The water which drains from the Separator can be returned to the mixing box by a small centrifugal pump, if desired.



The Knowles Spirojector Condenser

The Knowles Spirojector Condenser

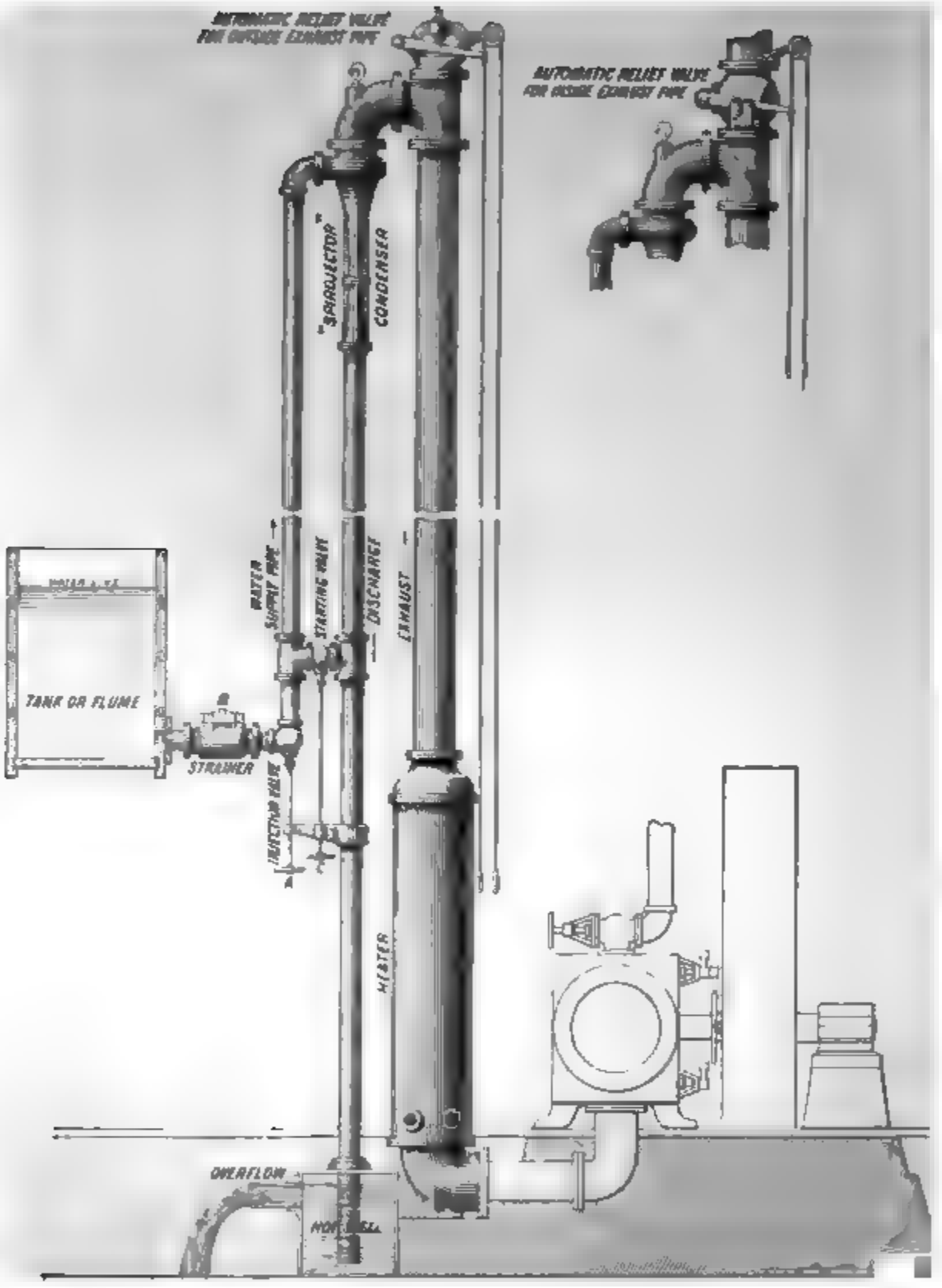
THE ENGRAVING opposite illustrates the Knowles "Spirojector" Condenser, which is a special form of the jet type of condenser, and the best yet introduced. Particular attention is called to the arrangement of the cone in the upper part of the condenser, whereby the injection water is made to take a spiral or rotary direction in its downward flow. This action tends to produce a more perfect effect in drawing down the air and vapor through the narrow or middle part of the condenser. *That is to say, the whirling action given to the injection water as it passes through the condenser to the discharge pipe can produce a better result, and with the use of less water for condensing the steam.*

The exhaust steam entering at the top of the condenser passes through the centre of the cone and meets the rapidly descending spiral current of water and is immediately condensed. The water column or discharge pipe should be sufficiently long between condenser and hot well to overcome the atmospheric pressure, so as to carry the air down into the hot well after it is drawn through the contracted neck of the condenser.

As shown, the injection water enters at the upper left hand side of the condenser, circulating around the cone before taking the spiral action above described.

The supply of injection water can be syphoned from a tank, flume or penstock after the vacuum is formed in the condenser, if ten or more feet head of water can be had above the overflow of hot well. If the head of water is less than ten feet, then it is necessary to use a pump. A centrifugal or rotary pump is generally used when the water flows to the pump by gravity. When the water has to be lifted by suction, a steam pump or power driven pump is used.

See following pages for additional information.



The Knowles Spirojector Condenser

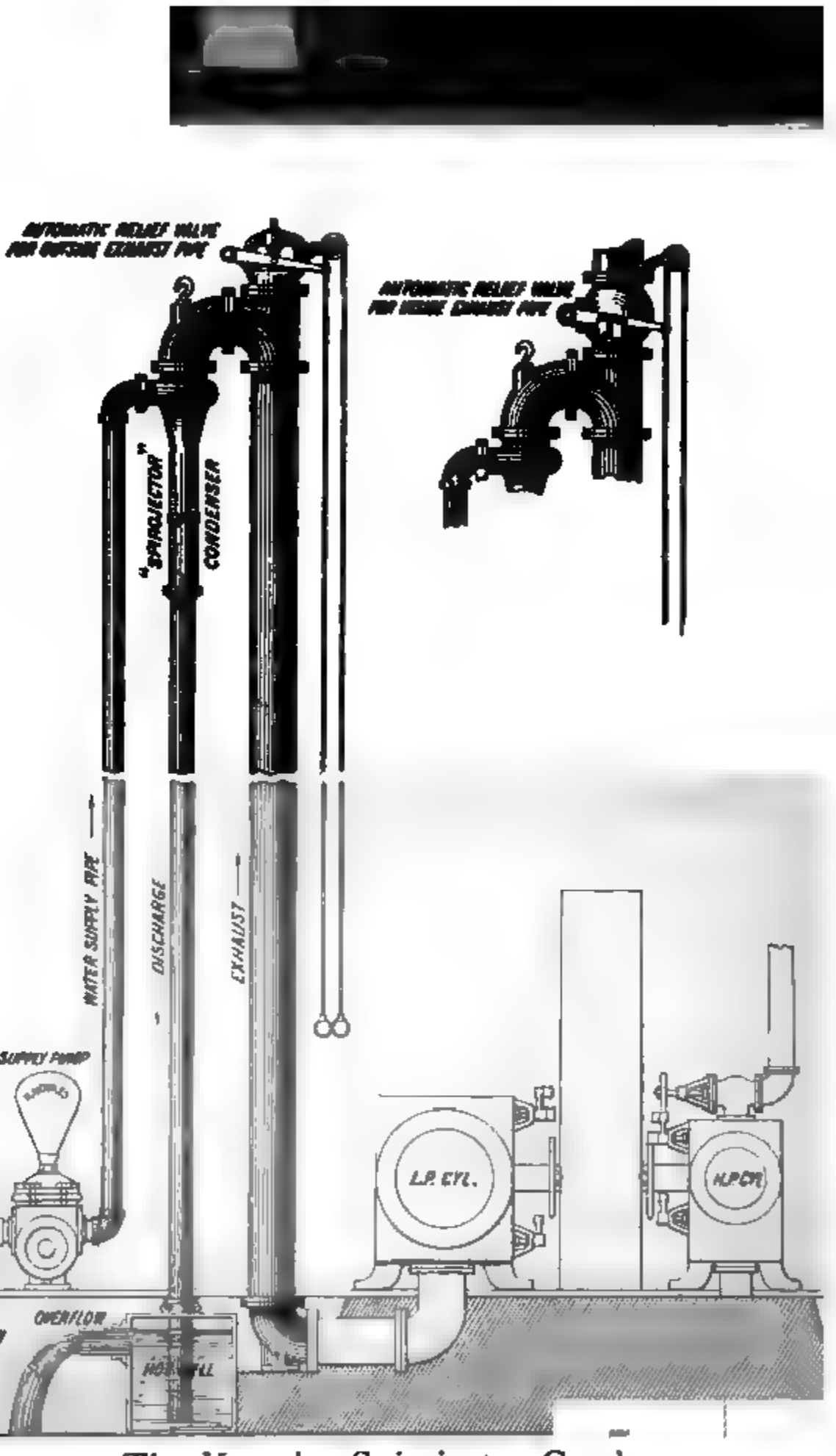
Syphoning Its Supply of Water from Flume or Penstock

The Knowles Spirojector Condenser

Syphoning Its Supply of Water from Flume or Penstock.

E ENGRAVING opposite represents the Knowles "Spirojector" Condenser as attached to a steam engine and drawing its supply of by "syphon" action from a tank, flume or other head of water. lan of water supply for the condenser is available where the head of is not less than 20 feet above the overflow pipe of the hot well. A pipe of sufficient size to prevent loss of pressure should be used to the injection water from flume, penstock or tank up to the nser. On this pipe is placed, at the most convenient point, an on valve (A) for regulating the supply of water. A proper screen or r with a large number of small holes should be placed over the end pipe in the flume or tank, or, if preferred, a Knowles Special Box er of ample size (as shown at "B") should be placed on the pipe. dvantage of this form of strainer is the convenience with which it can ned and cleaned.

he cross-pipe and valve shown at "C" is for the purpose of starting cuum in the discharge pipe of condenser, and when sufficient n is formed to cause the water to flow up the supply-pipe and h the condenser, then this special valve (C) is closed, and the t of injection water is adjusted by the injection valve "A." If the f water should fall to about 10 feet above overflow of hot well, after acuum is once formed, the condenser will continue to syphon its as long as the vacuum is kept up.



The Knowles Spirojector Condenser

As Supplied with Injection Water from a Pump

The Knowles Spirojector Condenser

As Supplied with Injection Water from a Pump.

: ENGRAVING opposite shows the manner of supplying the Knowles "Spirojector" Condenser with injection water when it be- necessary to use a pump of some kind to lift the water the height ary to insure a proper supply, say where the height of water is less o feet above the hot well. This arrangement is very simple and economical, as the pump has very little work to do in elevating the except when first starting the condenser.

he engraving shows so clearly this very simple arrangement that description is hardly necessary. The type of pump shown opposite regular direct-acting steam pump of the Knowles piston pattern, lift- supply of water through suction-pipe. When the injection water can ite to the pump, a centrifugal or other form of rotary pump can be either driven from shafting or by a small steam engine. Where a is used, it has been found that the power required is considerably less hat used for running an air pump and condenser. Taking into account mplicity and durability, as well as the economy of this kind of con- r, it can readily be seen that it is far the cheapest condenser in the un, even where a pump has to be used.

The Knowles Improved Fire Pumps

AMONG OUR various designs of Pumping Machinery we have made a specialty of manufacturing Steam Fire Pumps adapted to heavy service and the requirements of places where fire protection is needed. We have given special attention to the demands of Insurance Companies and careful buyers.

As there are different systems of fire protection where Steam Pumps are used as a source of pressure, it becomes necessary to the good working of any system that a pump be adapted to the service for which it is intended. This has led us to a subdivision of this class of our machinery, and we have now a full line of patterns for the different varieties and sizes enumerated in this Catalogue.

We built the FIRST UNDERWRITER FIRE PUMP that was ever made in the United States—it was sold in July, 1890, and installed at the Arnold Print Works, North Adams, Mass., in November, same year—we have been building them ever since, and now have more of these pumps in successful operation than any other maker in the world.

Our Guarantee.

Every fire pump built by us is thoroughly tested before leaving the works, by running it from two to six hours against from 100 to 250 pounds pressure to the square inch. Each pump is guaranteed to perform the service for which it is sold—providing always that it be properly connected up—and in case of failure, the pump may be returned and the money will be refunded.

KNOWLES STEAM PUMP WORKS.

The Knowles Underwriter Fire Pump

Mutual Insurance Companies' Specifications.

IN OUR Underwriter Fire Pump, the water passages, valve areas, and suction and discharge nozzles are all much larger than in any ordinary pump, so a greater amount of water can be discharged without water-hammer. Also, the steam and exhaust ports and nozzles are designed so as to give unrestricted passage to the steam. The pump is "rust-proof," and will start instantly, after standing unused for a long time. The piston rods and valve rods are made from Tobin bronze. All stuffing-boxes and glands are brass lined. Plungers and plunger sleeve are of composition, but the metals are differently mixed to prevent cutting. This mixture of the metals has been a subject of much experiment and study; it has now brought us great success, as the parts work perfectly upon each other, without friction or impairment.

Each pump has the following fittings, heretofore charged as extras but now included in the price and regularly furnished.

Capacity-Plate on Discharge Air-Chamber.
Stroke-Gauge, graduated on each end.
Vacuum, or Suction Air-Chamber.
Steam-Gauge, 5 inches diameter.
Water-Gauge, 5 inches diameter, with duplex spring.
Relief-Valve of large capacity.
Relief-Valve Discharge-Cone.
Set of brass priming Pipes and special valves.
Required number of $2\frac{1}{2}$ inches Ludlow Hose-Valves.
One pint Sight-Feed Cylinder Lubricator.
All according to the specifications.

On account of the larger passageways, brass parts and attachments mentioned, the pump necessarily costs more than an ordinary fire pump; but the cost by the gallon discharged is less, since the Underwriter Pump can deliver a greater quantity of water in the same length of time. It is also much heavier and stronger, with superior workmanship, and better protected from rust and accident.

Details of Construction.

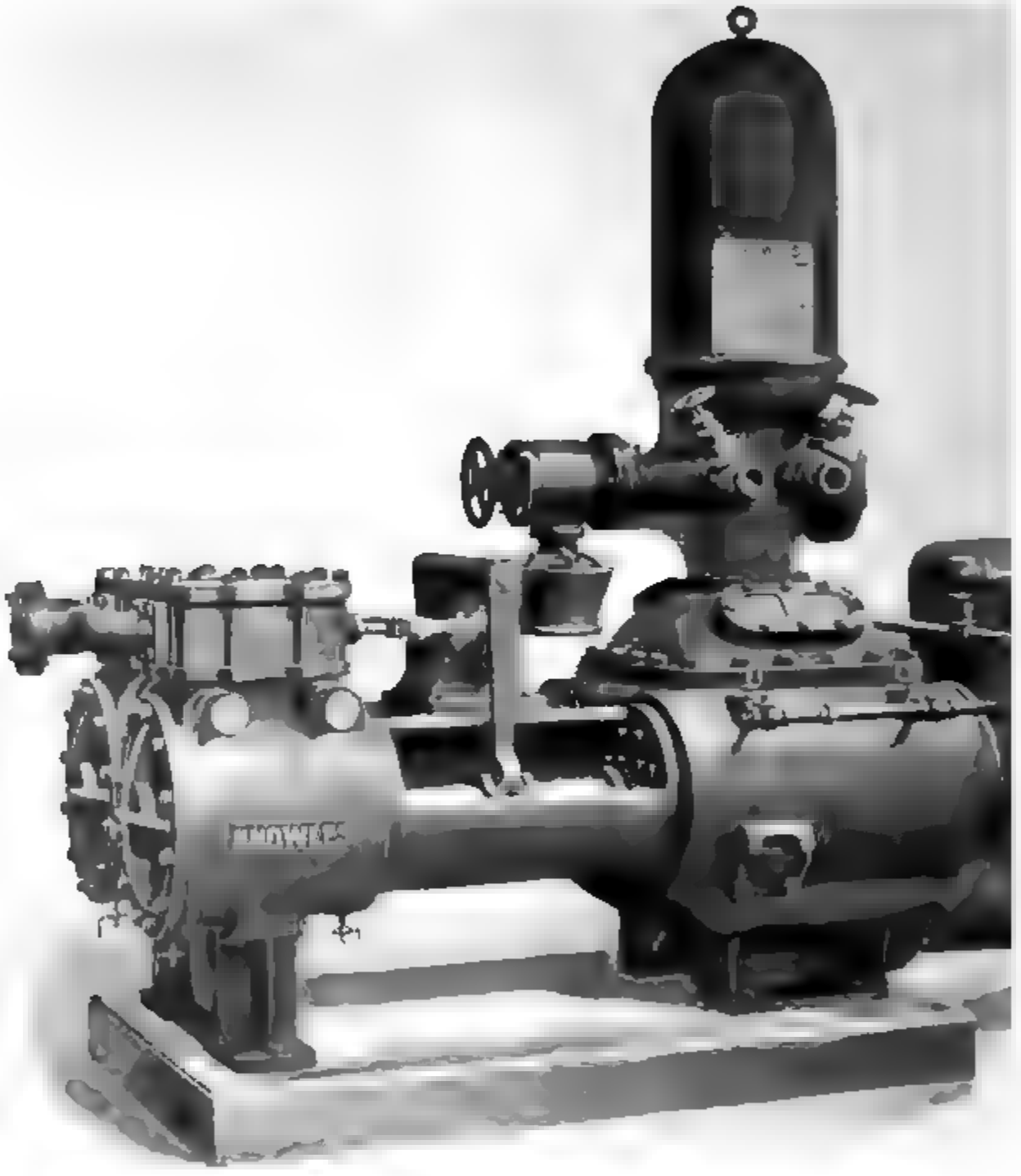
All valves are made of specially vulcanized rubber and provided with brass backings, upon which the springs rest in grooves, and are kept from drifting sidewise from the centre. Valve springs are coiled upon a cylindrical arbor, and made with stiffness to allow the correct lift of valve.

The valve seats are cast from United States gun-metal composition, firmly secured to the cylinder by forcing in on a taper and beading down on the under side. The valve area in all sizes is greater than specified by the Underwriters.

The smallest areas of steam and exhaust ports are made so there will be no wire drawing of steam, nor any choking of exhaust. This adds to the steadiness of the stroke. The edges of steam valve-ports and valves are accurately milled, chipped, and filed to templates, and the valve seats scraped to a plain surface in a most thorough and workmanlike manner.

The clearance space between piston and cylinder head is brought down to the smallest amount; the contact surfaces are flat, without projection of any nuts, except the piston rod nut, that enters pocket in back cylinder head.

The cushion is made by a special arrangement of cushion ports. It is to prevent the possibility of pump pounding itself to pieces in case of a sudden release of load, caused by a break in the suction or discharge



The Knowles Underwriter Fire Pump

Mutual Insurance Companies' Specifications

(Cut Shows Pump of 1000 Gallons Capacity)

[redacted]

We make a steam cushion release with an independent port terminating one-half inch back from
er head, instead of a release through the induction-port opening, as at present designed by many pump
acturers. By this means, an amount of steam is cut off from escaping through the exhaust port, and, being
ssed, will save the piston from striking the head. The pump is therefore safe, in case the cushion
e left open too wide.

e also furnish a stroke-gauge, upon which the exact length of stroke is indicated, showing any wrong
ment of cushion-valves or stuffing-boxes.

e sizes of suction and discharge pipes are exactly in keeping with the specifications, and are larger
r common use. They help the action of the pump, making it run smoothly at very high speed, and
pletely at each stroke. Our patterns are designed so that the suction inlet can be placed on the
l end or either side, or in all three positions, when desired. We place this inlet where it will be most
t, namely, on forward end, unless otherwise ordered.

: also furnish a vacuum or suction air chamber. (This can be omitted by special agreement in cases
he water is taken from an open reservoir by a pipe of full specified size less than 20 feet long.) This
air chamber does not prevent taking off the water cylinder heads. The discharge air chamber is
to 400 pounds to the square inch, and covered on the inside and outside with composition light paint,
nish its porosity.

e water-relief or safety-valve is set to a working pressure of 100 pounds to the square inch, and is of
pacity for each pump that it can pass all the water discharged when running at two-thirds speed, at a
e not exceeding 125 pounds. The hand-wheel is marked to show which way it should be turned to
: or reduce pressure.

open cone or funnel is attached to discharge nozzle of relief valve to show the engineer any water
:

p cocks, with lever handles, are furnished on both ends of water and steam cylinders; also drain
re placed for drawing off water above discharge valves. Brass air cocks, with lever handles, are
d on top of each plunger chamber for relieving pump of air while priming

: priming device consists of one inch brass pipe, with check valves leading into both ends of water
s, and fed from a tank through a two inch brass pipe, and operated by a two inch globe valve.

h pump is fitted with the required number of 2½ inch Ludlow hose valves, straightway opening, and
composition (no cap and chain). The hose screw ends of these valves are left blank, unless a sample
sent to cut them by before pump is shipped. This is on account of the lack of standard hose threads,
departments of different localities having special threads.

ore shipment, every pump is tested in our works at its rated speed of 70 to 75 revolutions, maintaining
pressure of 100 pounds to the square inch. Furthermore, pump is put to a severer trial by taking off
he heads on water cylinders and running on "three legs," so to speak, to ascertain if there be any
between the plunger and its ring. These tests are very carefully made and recorded.

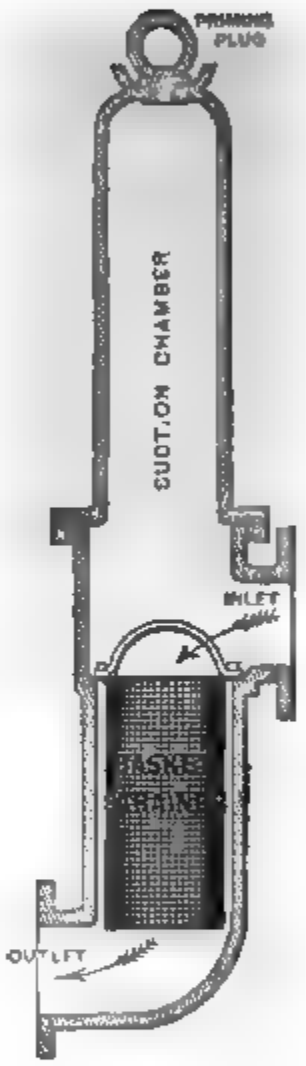
Table of Sizes and Capacities.

er m ers	Diameter of Water Plungers	Length of Stroke	Normal Capacities, Gallons per Minute	Number of Fire Streams	Steam Pipe	Exhaust Pipe	Suction Pipe	Discharge Pipe	Code Word
	6	12	320	1	2½	3	6	5	Ensign
	7¼	12	500	2	3	4	8	6	Ensigncy
	9	12	750	3	3½	4	10	7	Enskied
	10	12	1000	4	4	5	12	8	Enslave
	12	16	1500	6	5	6	14	10	Ensnarl

e actual capacity of each pump is more than the Underwriters' rating, and a greater speed can be
d, that will increase the number of fire streams.

The Knowles "Side Pipe and Strainer"

With and Without Suction Chamber Attached.



IT IS always very desirable to place an efficient strainer on the suction pipe of a pump where there is any suspicion that the water contains dirt or sediment. We recommend the Knowles "side pipe and strainer," with or without suction chamber attached, as shown by engraving, which should always be placed close to the pump The strainer basket inside can be readily taken out and cleaned This arrangement is a great improvement on the method commonly practiced in putting strainers on the end of the suction pipe, where it is more or less inconvenient to get at to clean or repair Should it be necessary to charge the pump with water, as is often the case with long suction pipes, the priming plug shown at top of suction chamber can be easily removed. For plain strainers, see next page

Sizes

Size of Suction Pipe . . Inches	2	2½	3	3½	4	5	6	8	10	1
Code Word, with Suction Chamber	a	b	c	d	e	f	g	h	i	j
Code Word without Suction Chamber	k	l	m	n	o	p	q	r	s	t

a. Entwist
b. Envassal
c. Envenom
d. Enviable
e. Envied
f. Envious
g. Environ
h. Envoy
i. Envying
j. Enwheel
k. Eocene
l. Eolian
m. Eolipile
n. Epanodos
o. Eparch
p. Epaulet
q. Epenetic
r. Epergne
s. Ephemera
t. Ephod

For Plain Suction Strainers, etc., see next page.

Check Valves and Foot Valves

These valves are made with flanged ends, as shown, or with screwed ends, at same price. When desired, they can be made with bell and spigot ends at a slight additional cost.

Fig. 1

Fig. 2

Size . . . . Inches	2	2½	3	3½	4	5	6	8	10	12	14	16	18	20
Check Valve, Fig. 1, Code Word	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Foot Valve, Fig. 2, Code Word	15	16	17	18	19	20	21	22	23	24	25	26	27	28

Strainers

Fig. 3

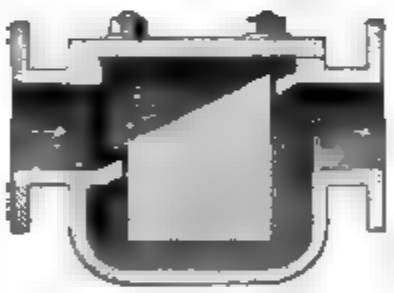


Fig. 4

Fig. 5

Size . . . . Inches	2	2½	3	3½	4	5	6	8	10	12	14
Flat Strainer, Fig. 3, Code Word	29	30	31	32	33	34	35	36	37	38	39
Basket Strainer, Fig. 4, Code Word .	40	41	42	43	44	45	46	47	48	49	50
Strainer and Foot Valve, combined, Fig 5, Code Word	51	52	53	54	55	56	57	58	59	60	61

1	Epicarp	12	Epilepsy	22	Epistle	32	Epulose	42	Equipage	52	Erbium	
2	Epicene	13	Epilogue	23	Epitaph	33	Epulotic	43	Equipped	53	Erebus	
3	Epicure	14	Epiphany	24	Epithet	34	Equable	44	Equitant	54	Eremite	
4	Epidemic	15	Epiphora	25	Epitome	35	Equal	45	Equity	55	Ereption	
5	Epidemy	16	Epiphyte	26	Epitrite	36	Equation	46	Equivoke	56	Erethism	
6	Epidictic	17	Epiplace	27	Epitrope	37	Equator	47	Erasable	57	Ergot	
7	Epidote	18	Episcopy	28	Epizoan	38	Equerry	48	Erase	58	Ergotism	
8	Epigene	19	Episode	29	Epoch	39	Equilibrium	49	Erasing	59	Eridanus	
9	Epigeous	20.	Episodic	30.	Epode	40	Equine	50	Erasion	60	Eremite	
10.	Epigram	21	Episperm	31.	Epulary	41	Equinox	51	Erasure	61	Erinnys	
11.	Epigraph											

Useful Information

Fire Streams

Work done by and Power Required for Fire Streams, using Rubber Hose and 1⅛ inch Smooth Nozzle.

G. A. Ellis, C. E., and A. P. Lashure.

Effective Pressure at Nozzle	Gallons Discharged in One Minute	Horizontal Distance Reached by Jet	Vertical Distance Reached by Jet	Pressure in Pounds Required at Hydrant or Pump to Maintain Given Effective Pressure at Nozzle With Different Lengths of Hose										Effective Pressure at Nozzle
				100 feet	200 feet	300 feet	400 feet	500 feet	600 feet	700 feet	800 feet	900 feet	1000 feet	
10	98	49	22	14	17	21	24	28	31	35	38	42	45	10
15	120	60	33	20	25	30	35	41	46	51	56	61	66	15
20	139	71	43	27	34	40	47	54	60	68	74	81	88	20
25	155	82	53	33	42	50	59	67	76	84	92	101	109	25
30	170	93	63	40	50	60	71	82	91	101	111	121	132	30
35	183	103	72	47	59	70	82	94	106		129	141	153	35
40	196	113	81	54	67	81	94	108	121	33	149	162	176	40
43	203	119	86	58	72	87	101	116	131	145	160	174	189	43
46	210	125	91	62	77	93	109	124	140	156	171	187	202	46
49	216	130	95	66	82	99	115	132	149	165	182	198	215	49
52	223	135	100	70	87	105	123	140	158	176	193	211	229	52
55	230	140	105	74	93	112	130	149	168	186	205	224	243	55
58	236	145	109	78	98	118	138	157	177	197	217	237	257	58
61	242	150	114	82	103	124	145	166	187	208	229	249	270	61
64	248	154	118	86	108	130	152	174	196	18	240	262	. .	64
67	253	159	122	90	113	136	159	182	205	28	251	274	.	67
70	259	163	125	94	118	143	166	191	215	239	263		. . .	70
72	263	165	128	97	122	146	171	196	221	246	.		.	72
74	266	168	130	99	125	150	176	201	227	25	.	. . .	. .	74
76	270	170	133	102	129	155	181	207	233		. .	. .	. .	76
78	273	173	135	105	132	159	186	212	239		. .	.	.	78
80	277	175	137	108	135	163	191	218	246			. .	.	80
82	280	178	139	110	139	167	195	224	.		. . .	.	. .	82
85	285	181	143	114	144	173	203	232				.		85
88	290	184	146	118	149	179	210	. . . .		.	. .			88
91	295	186	149	123	154	186	217	.		.	.	.	.	91
94	300	188	152	127	159	192	225			.	.			94
97	305	191	154	131	165	198				. .	. .	.	. .	97
100	310	193	157	135	170	205		.		.			. .	100

Water

DOUBLING THE diameter of a pipe increases its capacity four times. Friction of liquids in pipes increases as the square of the velocity. The mean pressure of the atmosphere is usually estimated at 14.7 pounds to the square inch, so that with a perfect vacuum it will sustain a column of mercury 29.9 inches, or a column of water 33.9 feet high.

TO FIND THE PRESSURE IN POUNDS TO THE SQUARE INCH of a column of water, multiply the height of the column in feet by .434. Approximately, we say that every foot elevation is equal to one-half pound pressure to the square inch; this allows for ordinary friction.

[redacted]

To Find the Diameter of a Pump Cylinder to move a given quantity of water in a minute (100 feet being the standard of speed), divide the number of gallons by 4, then extract the square root, and the product will be the diameter in inches of the pump cylinder.

To Find Quantity of Water elevated in one minute, running at 100 feet of piston speed in a minute. Square the diameter of the water cylinder in inches, and multiply by 4. Example: Capacity of a 5 inch Cylinder is desired. The square of the diameter (5 inches) is 25, which, multiplied by 4, gives 100, the number of gallons in a minute (approximately).

To Find the Horse Power necessary to elevate water to a given height, multiply the total weight of the water in pounds by the height in feet, and divide the product by 33,000 (an allowance of 25 per centum should be added for water friction, and a further allowance of 25 per centum for loss in steam cylinder).

The Area of the Steam Piston, multiplied by the steam pressure, gives the total amount of pressure that can be exerted. **The Area of the Water Piston**, multiplied by the pressure of water to the square inch, gives the resistance. A **Margin** must be made between the **Power** and the **Resistance** to **Move** the pistons at the required speed — say from 20 to 40 per centum, according to speed and other conditions.

To Find the Capacity of a Cylinder in gallons. Multiplying the area in inches by the length of stroke in inches will give the total number of cubic inches: divide this amount by 231 (which is the cubical contents of a United States gallon in inches), and product is the capacity in gallons.

Cast-iron Pipe

Size, thickness of Metal and Weight of a Length, including Bells, for different sizes and under various heads of water.

Size. Inside Diameter	25 ft Head or 10.82 Pounds Pressure		50 ft Head or 21.65 Pounds Pressure		100 ft. Head or 43.30 Pounds Pressure		150 ft. Head or 64.85 Pounds Pressure		200 ft. Head or 86.60 Pounds Pressure		250 ft. Head or 108.25 Pounds Pressure		300 ft. Head or 129.90 Pounds Pressure		Contents in Gallons for 1 ft. in Length.
	Thickness of Metal	Weight of a Length	Thickness of Metal	Weight of a Length	Thickness of Metal	Weight of a Length	Thickness of Metal	Weight of a Length	Thickness of Metal	Weight of a Length	Thickness of Metal	Weight of a Length	Thickness of Metal	Weight of a Length	
2	.255	54	.294	63	.312	67½	.330	72	.348	76½	.366	81	.384	86	.163
3	.320	132	.344	144	.353	149	.362	153	.371	157	.380	161	.390	166	.367
4	.335	180	.361	197	.373	204	.385	211	.397	218	.409	226	421	235	.652
5	.375	315	.403	315	.411	330	.429	345	.447	361	.465	377	.483	393	1.469
6	.433	450	.422	445	.450	475	.474	502	.498	529	.522	557	.546	584	2.611
7	.442	576	.450	600	.480	641	.519	682	.540	723	.570	766	.600	808	4.081
8	.448	720	.491	768	.527	826	.563	885	.599	944	.635	1004	.671	1064	5.875
10			.524	952	.566	1031	.608	1111	.650	1191	.692	1272	734	1352	7.907
12			.580	1215	.604	1253	.652	1380	.700	1483	.748	1585	.796	1673	10.44
14			.587	1370	.643	1500	.697	1630	.751	1761	.805	1894	.859	2026	13.22
15			.622	1583	.682	1703	.742	1924	.802	2086	.862	2245	.922	2412	16.42
24			.687	2120	.750	2340	.831	2580	.903	2811	.975	3045	1.047	3270	23.50
30			.775	3020	.875	3370	.965	3735	1.055	4095	1.145	4455	1.235	4822	36.72
36			.882	4070	.960	4581	1.008	5086	1.200	5613	1.314	6133	1.422	6650	52.58
48			1.078	6016	1.222	7521	1.366	8431	1.510	9340	1.654	10254	1.798	11165	94.02

All pipe cast in lengths of 12 feet, except the 2 inches, which are cast 9 feet long.
Pipes with flanges weigh about 15 per centum more than above.
Packing of Rubber for flanged pipe is usually ⅛ inch thick, and weighs about 10 pounds to the square yard.

Weight and Capacity of Different Standard Gallons of Water.

	Cubic Inches in a Gallon	Weight of a Gallon in Pounds	Gallons in a Cubic Foot	Weight of a cubic foot of water, English standard, 62.321 lbs. Avoirdupois
Imperial or English	277.274	10.00	6.232102	
United States	231.	8.33111	7.480519	

Weight of Crude Petroleum, 6½ lbs. per United States gallon } 42 gallons to the barrel.
Weight of Refined Petroleum, 6½ lbs. per United States gallon }
A "miner's inch" of water is approximately equal to a supply of 12 United States gallons per minute.

Table of Capacity of Pumps

The figures at the extreme right and left of the table are piston, or plunger diameters, the line of figures across the top are piston, or plunger, strokes; the figures in the body of the table are the capacity or displacement, in gallons, corresponding to a single stroke. To find the capacity for one revolution, multiply the capacity for a single stroke by one, two, or three, for single, duplex, or triplex single-acting pumps; and by two, four, or six, for double-acting pumps

Table Showing Capacity of Pumps of Given Diameter and Length of Stroke

Dia of Cyl Ins	Length of Stroke in Inches, and Capacity per Stroke in Gallons of Pump Cylinder, with Given Diameter																Dia. of Cyl. Ins.
	2	3	4	5	6	7	8	9	10	12	14	15	16	18	20	24	
1¼	.0106	.0159	.0212	.0266	.0311	1.472	.0425	.0478	.0531	.0637	.0743	.0797	.0848	.0955	.1062	.1274	1¼
1⅜	.0128	92	.0256	0321	0385	0419	.0513	.0578	.0642	.077	.089	.0963	.1027	.1156	1280	1541	1⅜
1½	.0153	.0220	.0306	.0382	.0434	0535	.0612	.0688	.0765	.0918	.1071	.1147	1224	.1377	1530	.1836	1½
1¾	.0208	0312	.0416	0521	0625	0729	.0833	.0937	1041	1249	.1457	.1562	1666	1874	.2082	.2499	1¾
2	.0272	0408	.0544	.068	0817	0952	1088	.1224	136	.1632	1904	.204	.2176	.2448	.2720	3264	2
2¼	.0344	.0516	.0688	.086	1033	1205	1377	1548	.1721	.2063	.241	.258	.2754	.3096	.3442	.4128	2¼
2½	.0425	.0937	.085	1062	1275	1487	.17	.1912	2125	.255	.2975	.3187	.34	.3825	.425	.51	2½
2¾	.0514	0771	1028	1285	1543	.1799	.2057	.2313	.2571	.3085	3598	.3855	.4114	.4626	.5142	.617	2¾
3	.0612	.0918	1224	1530	1836	2142	.2448	.2754	.306	.3672	.4284	.459	.4896	5508	.612	.7344	3
3¼	0718	1077	1436	1795	2154	2513	2872	.3231	3594	.4312	.503	.5385	5748	.6466	7182	.8624	3¼
3½	.0833	1249	1666	2082	2499	2915	.3332	3748	.4165	.4998	5831	.6247	.6664	.7497	.833	.9996	3½
3¾	.0956	1434	191	239	2868	3346	.3824	.4302	.478	5736	.6692	.687	7648	.8605	.9561	1 147	3¾
4	1088	1632	2 76	272	.3264	.3808	.4352	.4896	544	.6528	7616	.816	.8704	.9792	1.088	1 3056	4
4¼	1228	1842	.2456	307	.3684	4298	.4912	.5526	.6141	7368	.8596	.921	.9824	1 105	1 228	1.473	4¼
4½	1377	2065	2754	3442	4131	4819	5508	.6196	.6885	.8262	.9639	1.0327	1.1016	1.2393	1.377	1.6524	4½
4¾	1534	2301	.3068	.3835	.4602	5369	.6136	.6903	.7671	.9204	1 073	1 15	1.227	1.38	1 534	1.84	4¾
5	17	.2550	3	425	51	595	.68	.765	.85	1 02	1 19	1.275	1.36	1.53	1.7	2.04	5
5¼	1874	.2811	748	.4685	5622	6559	.7496	.8433	9371	1 124	1.311	1.405	1.499	1.686	1 874	2.248	5¼
5½	.2057	.3085	4113	5142	.6171	7199	8228	.9256	1.0285	1.2342	1.4399	1 5427	1.6456	1.8513	2.057	2.4684	5½
5¾	.2248	3372	4496	.562	.6744	7868	8992	1.011	1 124	1 348	1 573	1 686	1 789	2.022	2.248	2.696	5¾
6	2448	3672	4896	.612	7344	.8568	.9792	1 1016	1.2240	1.4688	1 7136	1.8362	1.9584	2.2032	2.448	2.9376	6
6¼	.2656	.3984	53	6640	7968	.9296	1 062	1 195	1 328	1 593	1.859	1.992	2.124	2.39	2.656	3 186	6¼
6½	.2872	.4308	5744	7182	.8616	1.0052	1 1488	1.2926	1.4364	1 7235	2 0109	2 1546	2 2982	2 5885	2 8728	3.4473	6½
6¾	.3098	.4647	6196	.7745	.9294	1.084	1.239	1 394	1 549	1.858	2 168	2.323	2.479	2.788	3.098	3.716	6¾
7	3332	.4998	.6664	833	.9996	1 1662	1 3328	1 4994	1 666	1.9992	2 3324	2.499	2.6656	2.9988	3 332	3.9984	7
7¼	.4084	.6126	.8168	1.021	1.225	1.429	1.633	1 837	2.042	2.45	2.858	3.063	3 266	3.674	4.084	4.9	7¼
8	.4352	6528	.8704	1.088	1 3056	1 4232	1 7408	1 9584	2 176	2.6112	3.0464	3.264	3.4816	3.9168	4.352	5.2224	8
9	.5508	.8262	1 1016	1 377	1.6524	1 9278	2.2032	2.4786	2.754	3 3048	3.8556	4 131	4.4064	5.0572	5.508	6.6096	9
10	.68	1.02	1.36	1 7	2.04	2.38	2 72	3.06	3 4	4.08	4.76	5.1	5.44	6 12	6.8	8.16	10
11	.8227	1 2341	1 6451	2.057	2.464	2 870	3.2902	3 7258	4 1139	4 9367	5.7595	6.1709	6.5823	7.4052	8.2279	9.8735	11

Friction of Water in Pipes

Friction loss in pounds per square inch for each 100 feet of different size clean iron pipe discharging given quantity of water per minute.

Gallons per Minute	Inside Diameter of Pipe																		
	¾ in.	1 in.	1¼ in	1½ in	2 in	2½ in	3 in.	4 in.	5 in.	6 in.	8 in	10 in	12 in.	14 in	16 in	18 in	20 in	24 in.	30 in.
5	3.3	.64	.31	12	..	..	.	..	....		..	....	. .	.	..	...	....	....	....
10	13.0	3.16	1.05	.47	.12	..	.	. ..	....	....		....		..	.	. .	..	....	....
15	28.7	6.98	2.38	.97	..	.		.. .	..	.		....		..	..	.	. .	....	. .
20	50.4	12.3	4.07	1.66	.42	. .	.		.. .	. .		....		.	. .	...	.. .	...	....
25	78.0	20.0	6.40	2.62	. ..	.21	10	..	....	.		....		...	...	..	.	. ..	. .
30	.. .	27.5	9.15	3.75	.91	...	...	. .	....			....	..	.	..	..	...	....	...
35	....	37.0	12.4	5.05	..	.	.	..	....	. .		....		.	.			. .	. .
40	....	48.0	16.1	6 52	1.60	.. .	....	....	....	.		....	..	. ..	. ..	....	..	. ..	...
45	....	....	20.2	8.15	....	....	....	..	....	.	.	....	.	.	...	.	.	. .	...
50	....	...	24.9	10.0	2.44	.81	.35	.09	0.03	...	. .	....	..	...	...	.	. ..	....	. .
75	....	....	56.1	22.4	5.32	1.80	.74	. .	0.06	.		....	.	....	.. .	.. .	.	...	...
100	. .	...	....	39.0	9.46	3.20	1.31	.33	0.10	.05	.	....	...	.	. .	.. .	....	....	....
125	....	....	....	...	14.9	4.89	1.99	. ..	0.16	..	. .	....	.	. .	..	.. .	.. .	...	....
150	.. .	.. .	....	....	21.2	7.00	2.85	.69	0.23	10		....	....	.	...	....	.	.. .	..
175	....	. .	....	....	28.1	9.46	3.85	. .	0.32	....	...	....	.	..	..			.	. .
200	.. .	..	....	...	37.5	12.47	5.02	1.22	0.42	17	.	....	...				..	....	.. .
250	. ..	..	...	. ..	...	19 66	7 76	1.89	n.65	.26	.07	.03	.01	. .		. .	. .	.	. ..
300	...	.	...	...	....	28.06	11.2	2 66	0.94	.37	.09	.04	....	..	.	..	....	....	....
350	...	.	....	...	.		15.2	3.65	1.28	.50	.12	.05	.02	.	. .	. .	.		. ..
400	...	.	. .	. .	..	..	19.5	4.73	1.68	.65	.16	.06	. .	..		..	.. .	....	....
450	...	. .	..	....	.	...	25.0	6.01	2.10	.81	.20	.07	.03	.	...	...	. .	. .	....
500	..	...	..	...	.	. .	30.8	7 43	2 70	.96	.25	.09	.04	.017	.009	.	...	....	....
750	...	...	....	...	...	.	.	.. .	5.40	2.21	.53	.18	.08	. .	...	.		.. .	.. .
1000	....	.	...	. .	. .	..	.	.	9.60	3.88	.94	.32	.13	.062	.030	. ..	...	....	...
1250	....	. .	....	....	..	.	. .	. .	. .	...	1.46	.49	.20	. .	.. .	. .	.	.. .	. ..
1500	...	. ..	....	....	..	..	.. .	...	. ..	..	2.09	.70	.29	.135	.071		..	...	....
1750	.. .	...	.. .	....	.. .	..	.	....	.. .	...	. .	.93	.38	.	..	.	. ..	..	....
2000	....	....	....	....	.	. .	..	.	.. .	. ..	..	1.23	.49	.234	.123	.	....	...	....
2250	. ..	...	....	....	...	. ..	...	. .	....	....	...	....	.63	....	....	....	.. .	. ..	....
2500	....	...	....	....	....	.. .	....	.. .	....	. .	....	....	.77	.362	.188	.107	....	....	....
3000	....	..	....	....	....	...	....	....	....	. ..	....	....	1.11	515	.267	.150	.091	.047	....
3500	....	. ..	....	....	.	.	.	..	....	...	. .	....	.. .	.697	.365	.204	....	. ..	....
4000	....	...	....	....	....	. .	....	....	....	....	....	....	....	.910	.472	.264	.158	.067	.022
4500	....	....	....	....	.	.		.. .	....	.. .	.. .	....	....	...	.593	.333	....	.. .	....
5000	....	..	....	....	.	.	.	. ..	....	....	....	....	....	....	.730	.408	.244	.102	.035
6000	....	. ..	...	. ..	..	. .		.	....	.. .	...	....	...	. .	. ..	.585	.348	.146	.048
7000	....	..	...	...	.				. . ..	....	...	....	. .	...	.. .	....	.472	.196	.065
8000	. ..	. ..	. ..	....	....	...	. .	...	....	....	....	....	....	....	....	....	.612	.255	.083
9000	...	....	....	....	..	.	.	..	....	...	....	....	....	....	.. .	....	....	.323	.105
10000	....	....	....	...	...	.	.	...	....	...	....	....	....	....	....	....	....	.398	.131

Table of Theoretical Horse Power Required to Raise Water to Different Heights

Gallons per Minute	5 feet	10 feet	15 feet	20 feet	25 feet	30 feet	35 feet	40 feet	45 feet	50 feet	60 feet	75 feet	80 feet	100 feet	125 feet	150 feet	175 feet	200 feet	250 feet	300 feet	350 feet	400 feet	Gallons per Minute
5	.006	.012	.019	.025	.031	.037	.044	.050	.056	.062	.075	.094	.100	.125	.156	.187	.219	.250	.312	.375	.437	.500	5
10	.012	.025	.037	.050	.062	.075	.087	.100	.112	.125	.150	.187	.200	.250	.312	.375	.437	.500	.625	.750	.875	1.000	10
15	.019	.037	.056	.075	.094	.112	.131	.150	.169	.187	.225	.281	.300	.375	.469	.562	.656	.750	.937	1.125	1.312	1.500	15
20	.025	.050	.075	.100	.125	.150	.175	.200	.225	.250	.300	.375	.400	.500	.625	.750	.875	1.000	1.250	1.500	1.750	2.000	20
25	.031	.062	.094	.125	.156	.187	.219	.250	.281	.312	.375	.469	.500	.625	.781	.937	1.094	1.250	1.562	1.875	2.187	2.500	25
30	.037	.075	.112	.150	.187	.225	.262	.300	.337	.375	.450	.562	.600	.750	.937	1.125	1.312	1.500	1.875	2.250	2.625	3.000	30
35	.043	.087	.131	.175	.219	.262	.306	.350	.394	.437	.525	.656	.700	.875	1.094	1.312	1.531	1.750	2.187	2.625	3.062	3.500	35
40	.050	.100	.150	.200	.250	.300	.350	.400	.450	.500	.600	.750	.800	1.000	1.250	1.500	1.750	2.000	2.500	3.000	3.500	4.000	40
45	.056	.112	.168	.225	.281	.337	.394	.450	.506	.562	.675	.844	.900	1.125	1.406	1.687	1.969	2.250	2.812	3.375	3.937	4.500	45
50	.062	.125	.187	.250	.312	.375	.437	.500	.562	.625	.750	.937	1.000	1.250	1.562	1.875	2.187	2.500	3.125	3.750	4.375	5.000	50
60	.075	.150	.225	.300	.375	.450	.525	.600	.675	.750	.900	1.125	1.200	1.500	1.875	2.250	2.625	3.000	3.750	4.500	5.250	6.000	60
75	.093	.187	.281	.375	.469	.562	.656	.750	.844	.937	1.125	1.406	1.500	1.875	2.344	2.812	3.281	3.750	4.687	5.625	6.562	7.500	75
90	.112	.225	.337	.450	.562	.675	.787	.900	1.012	1.125	1.350	1.687	1.800	2.250	2.812	3.375	3.937	4.500	5.625	6.750	7.875	9.000	90
100	.125	.250	.375	.500	.625	.750	.875	1.000	1.125	1.250	1.500	1.875	2.000	2.500	3.125	3.750	4.375	5.000	6.250	7.500	8.750	10.000	100
125	.156	.312	.469	.625	.781	.937	1.094	1.250	1.406	1.562	1.875	2.344	2.500	3.125	3.906	4.687	5.469	6.250	7.812	9.375	10.937	12.500	125
150	.187	.375	.562	.750	.937	1.125	1.312	1.500	1.687	1.875	2.250	2.812	3.000	3.750	4.687	5.625	6.562	7.500	9.375	11.250	13.125	15.000	150
175	.219	.437	.656	.875	1.093	1.312	1.531	1.750	1.968	2.187	2.625	3.281	3.500	4.375	5.468	6.562	7.656	8.750	10.937	13.125	15.312	17.500	175
200	.250	.500	.750	1.000	1.250	1.500	1.750	2.000	2.250	2.500	3.000	3.750	4.000	5.000	6.250	7.500	8.750	10.000	12.500	15.000	17.500	20.000	200
250	.312	.625	.937	1.250	1.562	1.875	2.187	2.500	2.812	3.125	3.750	4.687	5.000	6.250	7.812	9.375	10.937	12.500	15.625	18.750	21.875	25.000	250

[redacted]

Table for Converting Feet Head of Water into Pressure per Square Inch

Feet Head	Pounds per Square Inch	Feet Head	Pounds per Square Inch	Feet Head	Pounds per Square Inch
1	.43	55	23.82	190	82.29
2	.87	60	25 99	200	86.62
3	1.30	65	28.15	225	97.45
4	1.73	70	30.32	250	108.27
5	2.17	75	32.48	275	119.10
6	2 60	80	34.65	300	129.93
7	3.03	85	36.81	325	140.75
8	3.40	90	38.98	350	151.58
9	3.90	95	41.14	375	162.41
10	4.33	100	43.31	400	173.24
15	6.50	110	47.64	500	216.55
20	8 66	120	51.97	600	259.85
25	10.83	130	56.30	700	303.16
30	12.99	140	60.63	800	346.47
35	15.16	150	64.96	900	389.78
40	17.32	160	69.29	1000	433.09
45	19.49	170	73.63	. .	. . .
50	21.65	180	77.96	. .	. . .

Table for Converting Pressure per Square Inch into Feet Head of Water

Pounds per Square Inch	Feet Head	Pounds per Square Inch	Feet Head	Pounds per Square Inch	Feet Head
1	2 31	55	126.99	180	415.61
2	4.62	60	138.54	190	438.90
3	6 93	65	150.08	200	461.78
4	9 24	70	161.63	225	519.51
5	11.54	75	173.17	250	577.24
6	13.85	80	184.72	275	643.03
7	16.16	85	196.26	300	692.69
8	18.47	90	207.81	325	750.41
9	20.78	95	219 35	350	808.13
10	23.09	100	230.90	375	865.89
15	34.63	110	253.98	400	922.58
20	46 18	120	277.07	500	1154.48
25	57.72	125	288.62	. .	. . .
30	69.27	130	300 16	. .	. . .
35	80 81	140	323.25	. .	. . .
40	92.36	150	346 34	. .	. . .
45	103.90	160	369.43	. .	. . .
50	115.45	170	392.52	. .	. . .

Areas of Circles

Diam.	Area	Diam.	Area	Diam	Area	Diam	Area	Diam	Area	Diam	Area	Diam	Area
1/16	.012	4 inches	12.56	13 inches	132.73	22 inches	380.13	31 inches	754.7	40 inches	1256.6	49 inches	1885.7
1/8	.049	1/8	15.60	1/8	143.13	1/8	397.60	1/8	779.3	1/8	1288.2	1/8	1924.4
3/16	.110	5 inches	19.63	14 inches	153.94	23 inches	415.47	32 inches	804.2	41 inches	1320.2	50 inches	1963.5
1/4	.196	1/8	23.75	1/8	165.13	1/8	433.73	1/8	829.5	1/8	1352.6	1/8	2002.9
5/16	.441	6 inches	28.27	15 inches	176.71	24 inches	452.39	33 inches	855.3	42 inches	1385.4	51 inches	2042.8
1 inch	.785	1/8	33.18	1/8	188.69	1/8	471.43	1/8	881.4	1/8	1418.6	1/8	2083.0
1/16	.994	7 inches	38.48	16 inches	201.06	25 inches	490.8	34 inches	907.9	43 inches	1452.2	52 inches	2123.7
1/8	1.227	1/8	44.17	1/8	213.82	1/8	510.7	1/8	934.8	1/8	1486.1	1/8	2164.7
3/16	1.767	8 inches	50.26	17 inches	226.98	26 inches	530.9	35 inches	962.1	44 inches	1520.5	53 inches	2206.1
1/4	2.405	1/8	56.74	1/8	240.52	1/8	551.5	1/8	989.8	1/8	1555.2	1/8	2248.0
2 inches	3.141	9 inches	63.61	18 inches	254.46	27 inches	572.5	36 inches	1017.8	45 inches	1590.4	54 inches	2290.2
1/8	3.976	1/8	70.88	1/8	268.80	1/8	593.9	1/8	1046.3	1/8	1625.9	1/8	2332.8
1/4	4.908	10 inches	78.54	19 inches	283.53	28 inches	615.7	37 inches	1075.2	46 inches	1661.9	55 inches	2375.8
3/8	5.939	1/8	86.59	1/8	298.64	1/8	637.9	1/8	1104.4	1/8	1698.2	1/8	2419.2
3 inches	7.06	11 inches	95.03	20 inches	314.16	29 inches	660.5	38 inches	1134.1	47 inches	1734.9	56 inches	2463.0
1/8	8.29	1/8	103.87	1/8	330.06	1/8	683.4	1/8	1164.1	1/8	1772.0	1/8	2507.1
1/4	9.62	12 inches	113.10	21 inches	346.36	30 inches	706.8	39 inches	1194.6	48 inches	1808.5	57 inches	2551.7
3/8	11.04	1/8	122.71	1/8	363.05	1/8	730.6	1/8	1225.4	1/8	1847.4	1/8	2596.7

Barometric Pressures at Different Altitudes, with Equivalent Head of Water and the Vertical Suction Lift of Pumps

Altitude	Barometric Pressure	Equivalent Head of Water	Practical Suction Lift of Pumps
Sea Level	14.70 pounds per square inch	33.95 feet	25 feet
1/4 mile (1320 feet) above sea level	14.02 " " "	32.38 "	24 "
1/2 " (2640 ") " "	13.33 " " "	30.79 "	23 "
3/4 " (3960 ") " "	12.66 " " "	29.24 "	22 "
1 " (5280 ") " "	12.02 " " "	27.76 "	20 "
1 1/4 " (6600 ") " "	11.42 " " "	26.38 "	19 "
1 1/2 " (7920 ") " "	10.88 " " "	25.13 "	18 "

Width of Belt in Inches	Horse Power per 100 Feet Velocity of Belt		Width of Belt in Inches	Horse Power per 100 Feet Velocity of Belt	
	Single Belt	Double Belt		Single Belt	Double Belt
1	.09	.18	12	1.09	2.18
2	.18	.36	14	1.27	2.55
3	.27	.55	16	1.45	2.91
4	.36	.73	18	1.64	3.27
5	.45	.91	20	1.82	3.64
6	.55	1.09	22	2.00	4.00
7	.64	1.27	24	2.18	4.36
8	.73	1.46	28	2.55	5.09
9	.82	1.64	32	2.91	5.82
10	.91	1.82	36	3.27	6.55
11	1.00	2.00	40	3.64	7.27

In the calculations for horse powers in the above table, the belt is assumed to run about horizontally; the semi-circumference of smaller pulley has been considered as the ordinary arc contact of belt. Any reduction of this contact will make approximate proportional reduction of horse power.

Horse Power Shafting Will Transmit

Diameter of Shaft in Inches	Revolutions per Minute									
	100	125	150	175	200	225	250	300	350	400
1 15/16	1.2 h. p.	1.4 h. p.	1.7 h. p.	2.1 h. p.	2.4 h. p.	2.6 h. p.	3.1 h. p.	3.6 h. p.	4.5 h. p.	5.0 h. p.
1 15/16	2.4 "	3.1 "	3.7 "	4.3 "	4.9 "	5.5 "	6.1 "	7.3 "	8.5 "	9.7 "
1 7/16	4.3 "	5.3 "	6.4 "	7.4 "	8.5 "	9.5 "	10.5 "	12.7 "	14.8 "	16.9 "
1 11/16	6.7 "	8.4 "	10.1 "	11.7 "	13.4 "	15.1 "	16.7 "	20.1 "	23.4 "	26.8 "
1 15/16	10.0 "	12.5 "	15.0 "	17.5 "	20.0 "	22.5 "	25.0 "	30.0 "	35.0 "	40.0 "
2 3/16	14.3 "	17.8 "	21.4 "	24.9 "	28.5 "	32.1 "	35.6 "	42.7 "	49.8 "	57.0 "
2 7/16	19.5 "	24.4 "	29.3 "	34.1 "	39.0 "	44.1 "	48.7 "	58.5 "	68.2 "	78.0 "
2 11/16	26.0 "	32.5 "	39.0 "	45.5 "	52.0 "	58.5 "	65.0 "	78.0 "	87.0 "	104.0 "
2 15/16	33.8 "	42.2 "	50.6 "	59.1 "	67.5 "	75.9 "	84.4 "	101.3 "	118.2 "	135.0 "
3 3/16	43.0 "	53.6 "	64.4 "	75.1 "	85.8 "	96.6 "	107.3 "	128.7 "	150.3 "	171.6 "
3 7/16	53.6 "	67.0 "	79.4 "	93.8 "	107.2 "	120.1 "	134.0 "	158.8 "	187.6 "	214.4 "
3 11/16	65.9 "	82.4 "	97.9 "	115.4 "	121.8 "	148.3 "	164.8 "	195.7 "	230.7 "	243.6 "
3 15/16	80.0 "	100.0 "	120.0 "	140.0 "	160.0 "	180.0 "	200.0 "	240.0 "	280.0 "	320.0 "
4 3/16	113.9 "	142.4 "	170.8 "	199.3 "	227.8 "	256.2 "	284.7 "	341.7 "	398.6 "	455.6 "
4 7/16	156.3 "	195.3 "	234.4 "	273.4 "	312.5 "	351.5 "	390.6 "	468.7 "	546.8 "	625.0 "

When Ordering Parts

OWING TO the fact of our having constructed pumps of the same size for different duties, and also on account of the improvements which we have made from time to time, during our long business career, it is ABSOLUTELY NECESSARY that all orders for parts should be accompanied with the MANUFACTURER'S SERIAL NUMBER of the pump for which said parts are required.

This number will be found stamped in some conspicuous position on every pump made by us. In the case of the triplex power pumps, there is a number plate which is always placed on the frame, and the SERIAL NUMBER is also stamped on the end of the crank shaft. On single and duplex power pumps, horizontal pattern, the number is always stamped on the crank pin and on the connecting rod strap; also on the outside flange of the water cylinder head. There is also a number plate placed generally on the frame, although sometimes it is placed on the water cylinder on the inside end. On air compressors the number is stamped on the edge of the flange of the cylinder, also on the edge of the cylinder head; and there is also a number plate placed on the centre piece.

As we manufacture every part to gauge, and have a complete record of all pumps built by us, we can send correct duplicate pieces on receipt of above information. Without manufacturer's number we CANNOT duplicate parts with certainty.

If the MANUFACTURER'S SERIAL NUMBER has become covered with rust, dirt or paint, take a file or a piece of emery cloth and rub at the point indicated above. This will bring out the MANUFACTURER'S NUMBER so that it can be easily read.

KNOWLES STEAM PUMP WORKS.

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No. 433.

PU...

SPECIAL CATALOGUE

1901

...LES STEAM PUMP WORKS

ELECTRIC AND POWER PUMPS

KNOWLES STEAM PUMP WORKS

MANUFACTURERS OF

POWER PUMPS, AIR COMPRESSORS, WATER-WORKS PUMPING ENGINES, CONDENSING APPARATUS, BOILER FEED, FIRE, HYDRAULIC AND LIGHT SERVICE PUMPS.

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INTRODUCTORY.

UNLIKE many machinery catalogues, the one presented herewith is compiled, not from designs and data of types as yet largely on the draughting board, and with the hope of influencing business by sheer force of novelty and ingenuity, but from knowledge of apparatus already built in our own shops, and thoroughly proven in actual service by customers throughout the world.

The immense variety of machinery in our manufacture enables us to adapt our pumps to the requirements of so many different industries that we are obliged, for the convenience of buyers, to specify the types; and we desire to prevent inconvenience and bewilderment caused by the searching of large catalogues for special apparatus. Therefore, the object of this publication is manifest; namely, to set before the public a catalogue in concise form, intended for their special use.

We fully realize its lack of completeness—the rapid advance in electrical engineering methods compels a corresponding activity in producing auxiliary apparatus—but we have tried to select such types as would probably meet the needs of the largest classes of our customers, omitting intentionally many designs not really obsolete, but adapted less for general than for special uses, and, of necessity, many patterns not yet standardized, or sufficiently tested under working conditions. In fact, we have intended, in preparing this catalogue, to make it largely suggestive, rather than authoritative, in character, knowing that satisfactory relations between manufacturer and customer can only be brought about by thorough understanding of the considerations involved in every case submitted, and hearty co-operation in securing the best possible results.

We are always pleased to confer with our patrons concerning pumping problems of every variety, and to render them every service in our power in obtaining the apparatus best suited to their requirements.

General Considerations.—While the fact that we manufacture *every variety* of pumping machinery, whether for operation by steam, air, hydraulic, electric or any other power, is, in itself, sufficient to show that our position is unprejudiced, there are certain elementary advantages in favor of electrical operation, as compared with other methods, which must always have great weight, unless counterbalanced by economical considerations due to special circumstances.

It is rare that the one feature of *economy* is made secondary to others, either of an æsthetic or personal nature, in purchasing apparatus of any kind, and, as a rule, the machine or *system producing the* greatest amount of *effective work* from

a given amount of primary energy will receive the most favorable consideration. Starting, therefore, from the coal pile, it is a well-known and easily proven fact that a direct-acting steam pump of the ordinary commercial type will require a greater coal consumption for a given service than a power pump of similar capacity electrically operated, and in spite of the intermediate efficiency losses in engine, generator and motor.

Another point often of weight in influencing a final decision is the compactness and flexibility of the connecting elements between the pump and its source of power supply. Properly insulated wires may be located in cramped spaces, or imbedded in walls, without providing facilities for inspection, when steam pipes would be entirely out of the question. The cost of maintenance and repairs on this part of an electric installation is also an item which counts heavily in favor of electric power.

Architects find in electric pumps the means for providing public and private buildings with elevator service, refrigeration, fire protection, etc., to a degree otherwise impossible without the constant employment of skilled engineers and assistants. By the use of roof or pressure tanks and proper automatic appliances for controlling the pumps, systems of this character may be maintained in constant readiness for occasional or protracted use, obtaining their current from the street lighting or power mains, with only such attention as any reasonably intelligent elevator boy or janitor is capable of giving, and without the jar and vibration inseparable from apparatus of a less refined type.

For Water-works service in towns and small cities, the use of electric power is in many cases the most economical solution of the pure water supply problem, which often means the growth or abandonment of a neighborhood. The same steam plant which lights their streets and homes at night, whether under direct municipal control or not, may be utilized by the citizens of enterprising communities for filling reservoirs during the day, thus getting a practically continuous service from the equipment, instead of having two separate outfits, each with its corps of attendants, and lying idle half the time. A water-power is often available, the energy of which may be transmitted by electrical means to the pumping plant miles away, thus eliminating entirely the element of fuel cost, and reducing expense to the simple items of interest and maintenance.

In Manufacturing Processes the electric pump is rapidly proving its valuable qualities for maintaining a constant pressure or output under varying conditions, or for providing an instantly available means of protection or special supply in case of emergency, either with or without automatic control. One of the not least valuable features of electrical operation under these circumstances is the fact that a motor consumes current almost exactly in proportion to the load; in other words, *though the speed* may remain the same, the consumption of current (save enough

to overcome the friction of its two bearings) ceases immediately upon the removal of the load, or in proportion as it is removed.

For All Purposes, the electric power pump appeals alike to the engineer, the purchaser and the operator by its simplicity, compactness, freedom from complicated or concealed mechanism, and general smoothness of operation.

It has been our policy to confine our attention strictly to the building of pumping apparatus, without taking up the manufacture of electrical devices of any kind, or favoring those of one make more than another. We are, therefore, in a position to supply our machinery in connection with any type of motor, keeping constantly in touch with the foremost manufacturers for this purpose, and having on file all information necessary for combining the electric and hydraulic portions of the apparatus in the most compact, efficient and economical manner, and with special reference to the service intended.

We confidently maintain that our machinery has no equal, on account of the extraordinary attention we have given to details and to workmanship, and the hearty interest we have taken in improvements. With our wide experience in this line, with special tools and machinery for building this class of work, we feel confident we can supply our patrons with the best machinery to be found on the market.

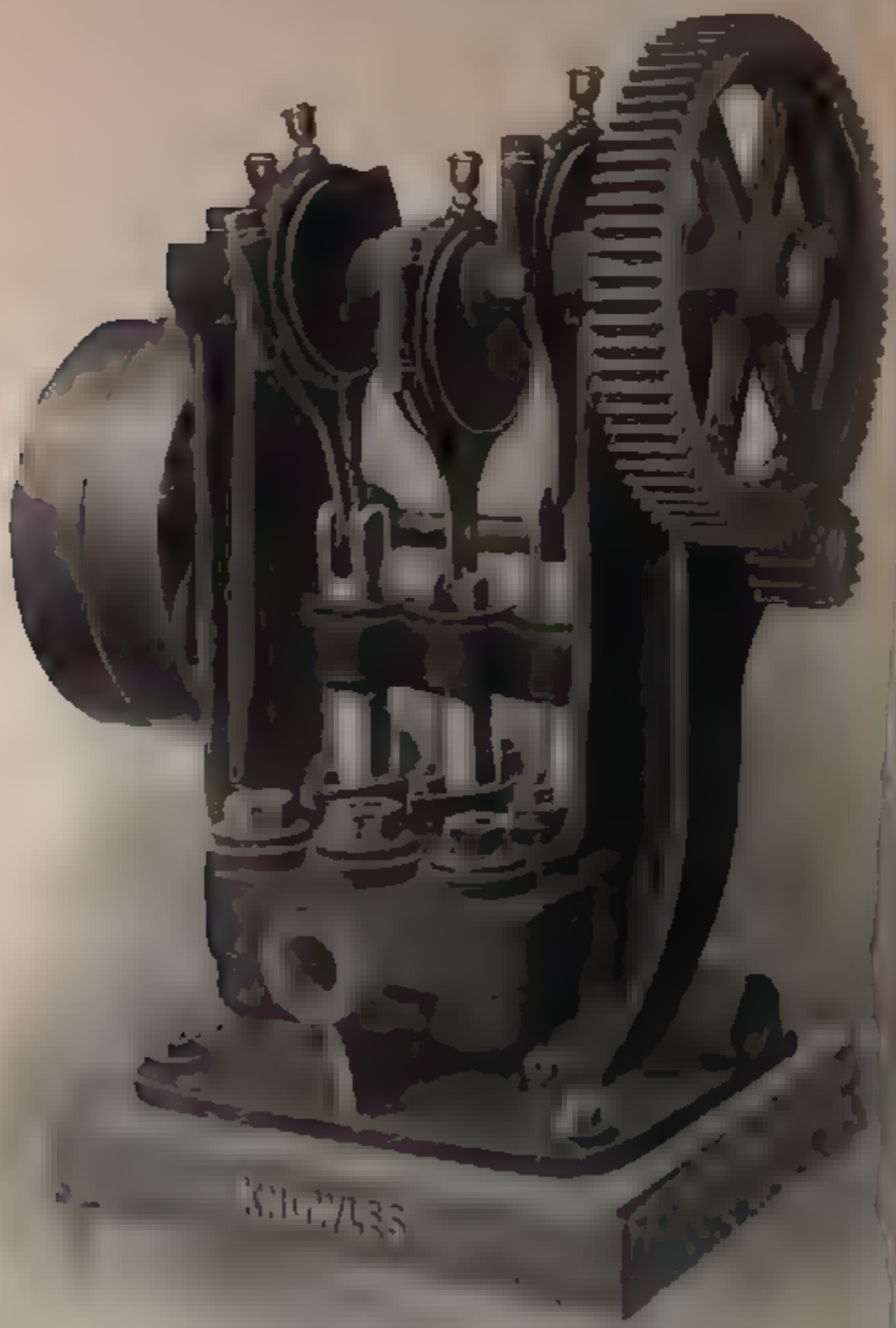
In the following descriptions we have omitted, necessarily, many points that are interesting, such as prices, weights, the best rules for setting up, and the like. For all such information we invite correspondence. Each purchaser, on sending us an order, is entitled to receive a blue-print drawing that shows the dimensions, position of foundation bolts, and all connections. For a more minute description of the details of our electric power pumps, we invite attention to the following pages.

Our Guarantee.—"We guarantee the herein described and specified machinery; that we will replace, without charge, within a year from shipment, any part which bears unmistakable evidence of imperfection in materials or workmanship. This company will use its utmost endeavors to fill its orders at the times promised, and expects to keep such promises, unless delayed by strikes, fire or other uncontrollable causes. It is obliged, however, because of demands sometimes made for consequential damages of various kinds, such as losses in operating mines, irrigation losses, failure to realize anticipated profits, or the saving in fuel consumption, etc., to notify its customers that it cannot consider itself responsible for any damages growing out of, or owing to, any delays whatever, and to advise them that all quotations and sales are made with the distinct understanding that these provisions are fully understood and acquiesced in. No responsibility is taken by this company in complying with time promised."

KNOWLES STEAM PUMP WORKS.

Knowles Vertical Triplex Power Pu

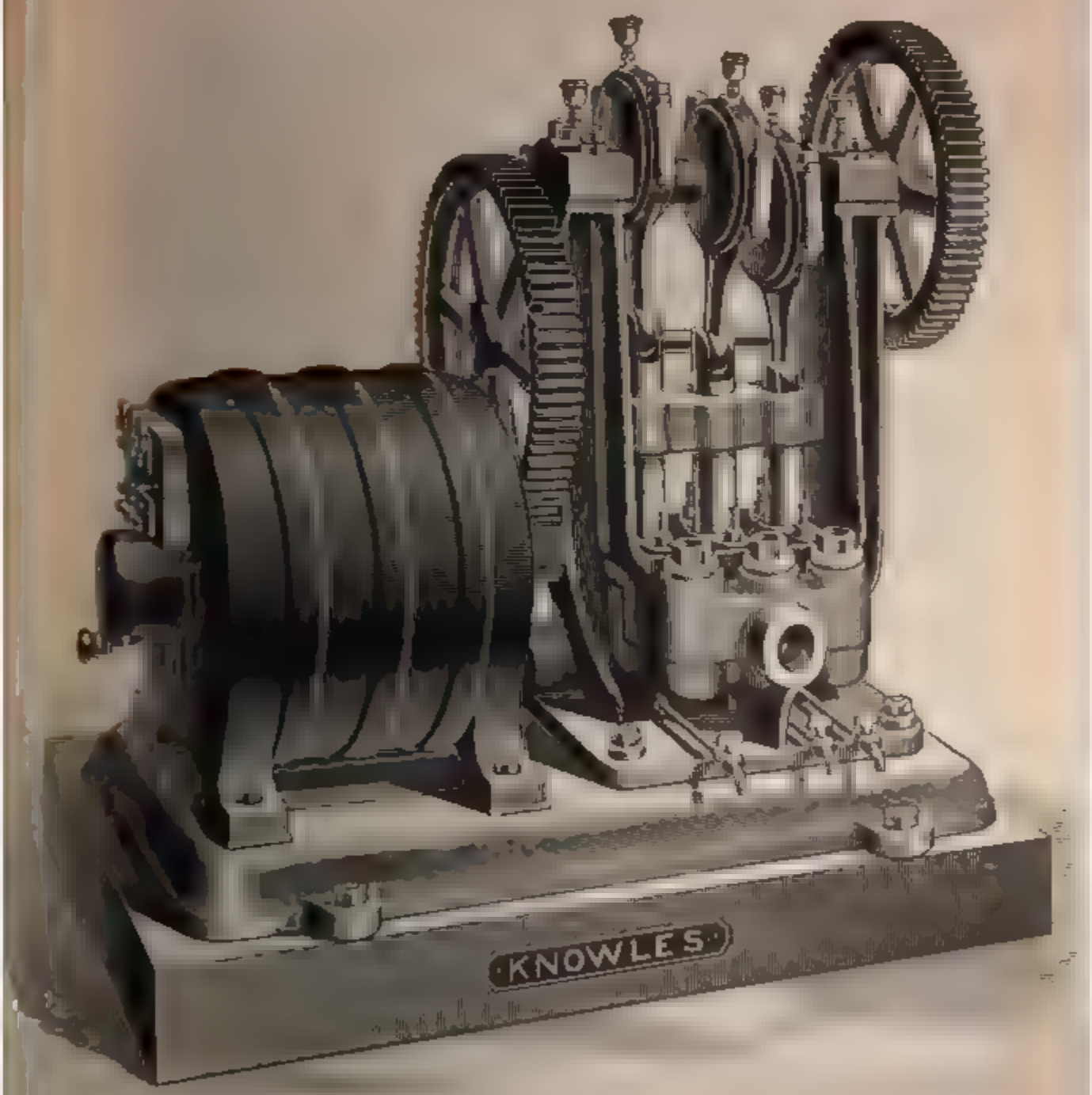
Style D—Belted Pump.



Size, 1¾ x 2½

Knowles Vertical Triplex Power Pump.

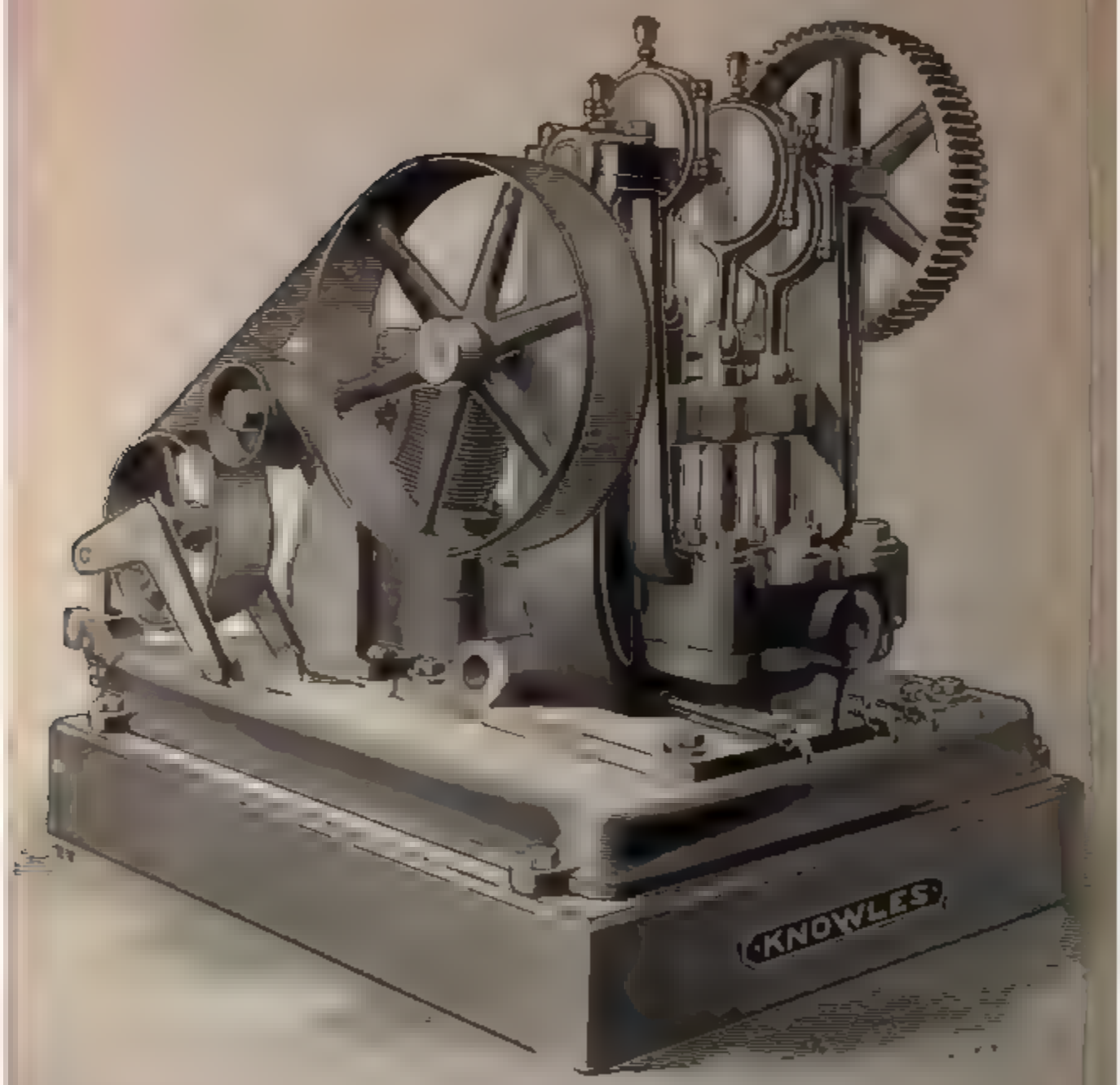
Style D—Electric Pump (Geared).



Size, 1¼ x 2½

Knowles Vertical Triplex Power Pump.

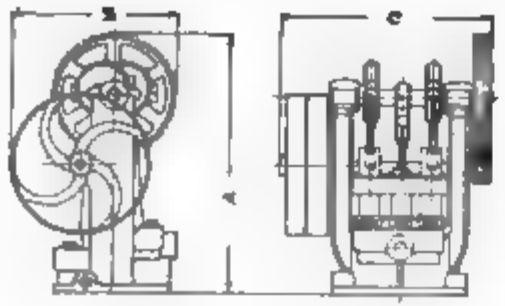
Style D—Electric Pump (Close Belted).



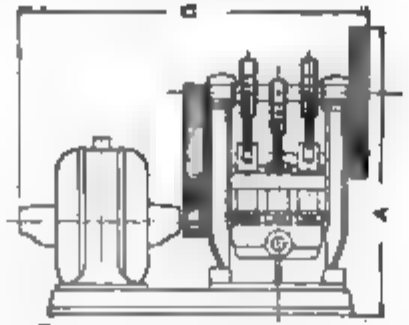
SIZE, 1¼ X 2½.

pumps, because the cranks are set at angles that will bring the plungers continuously upon the water column, without any shock from reversing the stroke; by this means the pumps discharge without pulsation, and the feed to the boiler is steady. The gears are cut, and the plungers are packed from the outside, so any leakage may be readily detected. The pump is easy to understand and take care of, it is a neat, compact design, and runs smoothly and noiselessly. These pumps can be used for a great variety of purposes, but are specially intended to supply the reservoir tanks of high office buildings or residences where the pressure carried on the city main is not sufficient to elevate water above the lower stories. There are two systems used, the open-tank and compression-tank systems. The open tank is placed in the upper part of the building and fitted with a ball float which rises and falls with the water, and opens and closes an electric switch, thereby automatically stopping and starting the pump and motor; no electric current is used, and the pump and motor stand idle, except when the water in tank gets low. With the compression system, a closed [illegible] the amount of water in the tank, starting when the water gets low and stopping when the water level rises. The control is effected by the air pressure in the tank, which pressure rises and falls as the water-level varies. The price of electric pump includes the pump complete, fitted with pulleys, belt, and belt tightener or gears, but it does not include the motor. We will furnish the motor and the regulating device required for either system, complete and ready for wire connections, if desired, at an extra price. The extended bed-plate for the electric type is designed especially to receive the specified type and size of motor. A pinion of fibre will be furnished for the armature shaft, so as to reduce the noise to a minimum, if specially ordered, at extra price; otherwise a cast-iron cut pinion will be furnished. All material is of the highest grade, and great care is taken in the test to prove there is no defect.

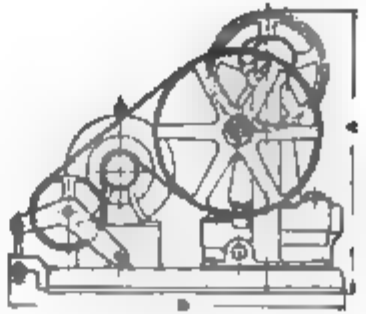
All sizes in the following list are suited for 150 pounds water pressure. In sending inquiries or orders, always state the water pressure.



Triplex Power Pumps (Belt Driven) 400 ft. Lift. Style "D."



Triplex Electric Pumps (Geared) 400 ft. Lift. Style "D."



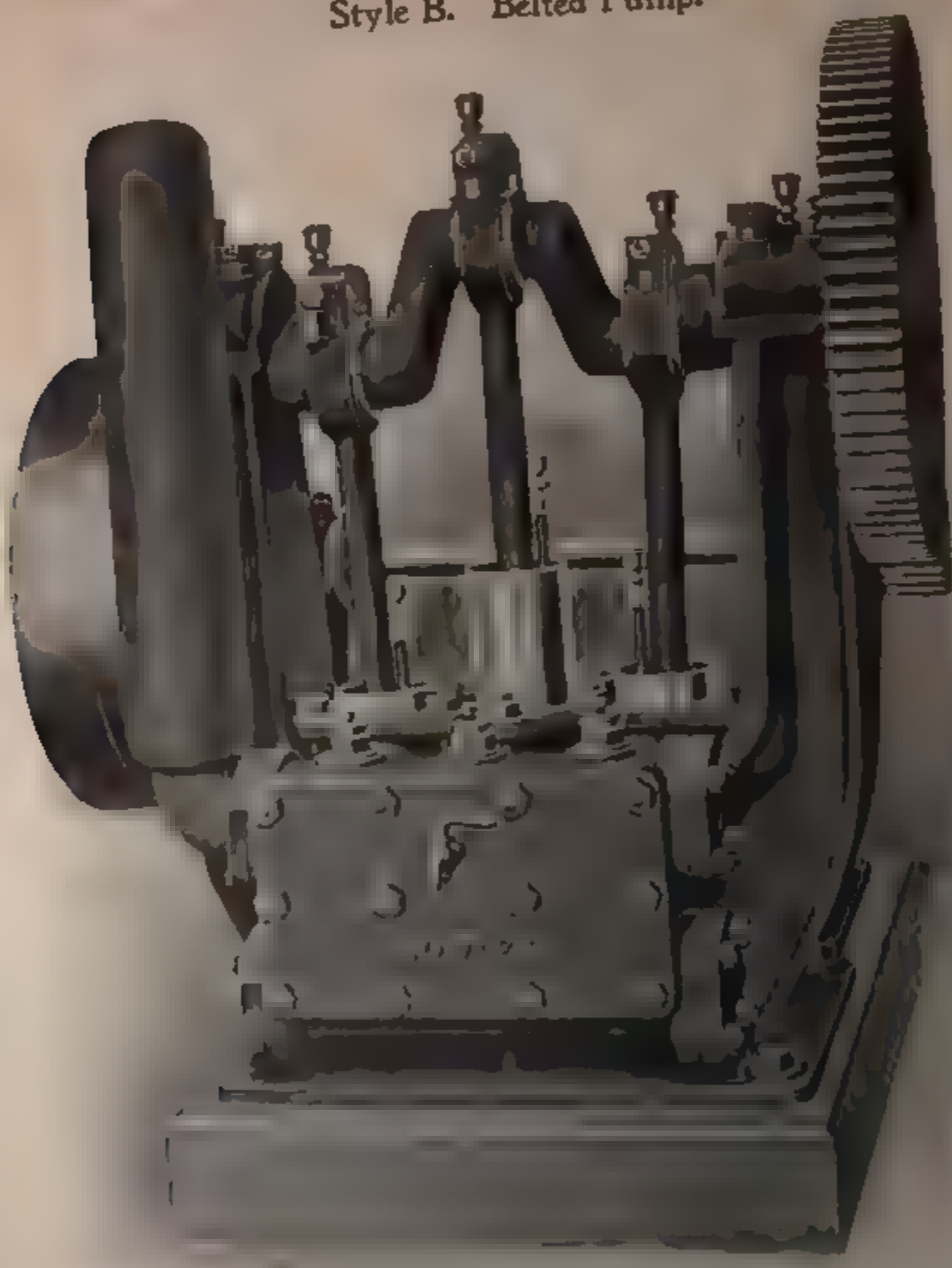
Triplex Electric Pumps (Close Belted) 400 ft. Lift. Style "D."

Diameter of Plungers.	Stroke.	Revs. per Min.	Gallons per Revolution.	Gallons per Minute.	Suction	Discharge	Pulleys, Tight and Loose. Diam.	Pulleys, Tight and Loose. Face	Ratio of Pump Gears.	Ratio of Motor Gears.	H. P. Motor Required	Dimensions Over All Belted Pumps Not Arranged for Motor. A	B	C	Dimensions Over All Arranged for Motor Geared. A	B	C	Dimensions Over All. Arranged for Motor Close Belted. A	B	C	Telegraphic Code Word. Belted Pumps Not Arranged for Motor.	Electric Pumps. Geared Arranged for Motor	Electric Pumps. Close Belted Arranged for Motor.
⅝	2	60	.0079	.474	½	½	12	1¼	5 to 1	To Suit Speed of Motor.	¼	19	13¼	15⅝	22	18½	29¾	25¼	31½	22½	Dabamos	Deadening	Debelo
⅞	2	60	.0156	.936	¾	¾	12	1¼	5 to 1		¼	19	13¼	15⅝	22	18½	29¾	25¼	31½	22½	Dabareh	Deadish	Debentem
1¼	2	60	.0319	1.914	¾	¾	12	1¾	5 to 1		½	19	13¼	15⅝	22	18½	29¾	25¼	31½	22½	Dabble	Deadly	Debentured
1¾	2½	60	.0780	4.680	1	1	12	1¾	5 to 1		1	22½	14½	19	29	21½	37	24½	31⅛	22⅛	Dabster	Deacon	Debicar
2	3	50	.1224	6.120	1¼	1¼	12	2½	5 to 1		1	27	16	24	29	23½	36½	30	33¼	24¼	Dado	Debate	Debilidad
2½	3	50	.1912	9.560	1½	1½	12	2½	5 to 1		1	28	17½	25¼	32	24	37⅛	31	36⅝	25	Daffodil	Debauch	Debilioris

The base for the close-belted pumps can be made of hard wood, with belt tightener independently secured to the floor by screws; we, however, recommend a cast-iron base, as per cut, on account of superior alignment.

Knowles Vertical Triplex Power Pump.

Style B. Belted Pump.



SIZE, 5 × 6

Sizes up to 4 x 6, inclosive, have outside guided plungers same as in illustr
on page 14, and the hollow frame is used as an air chamb

Knowles Vertical Triplex Pumps—Style "B."

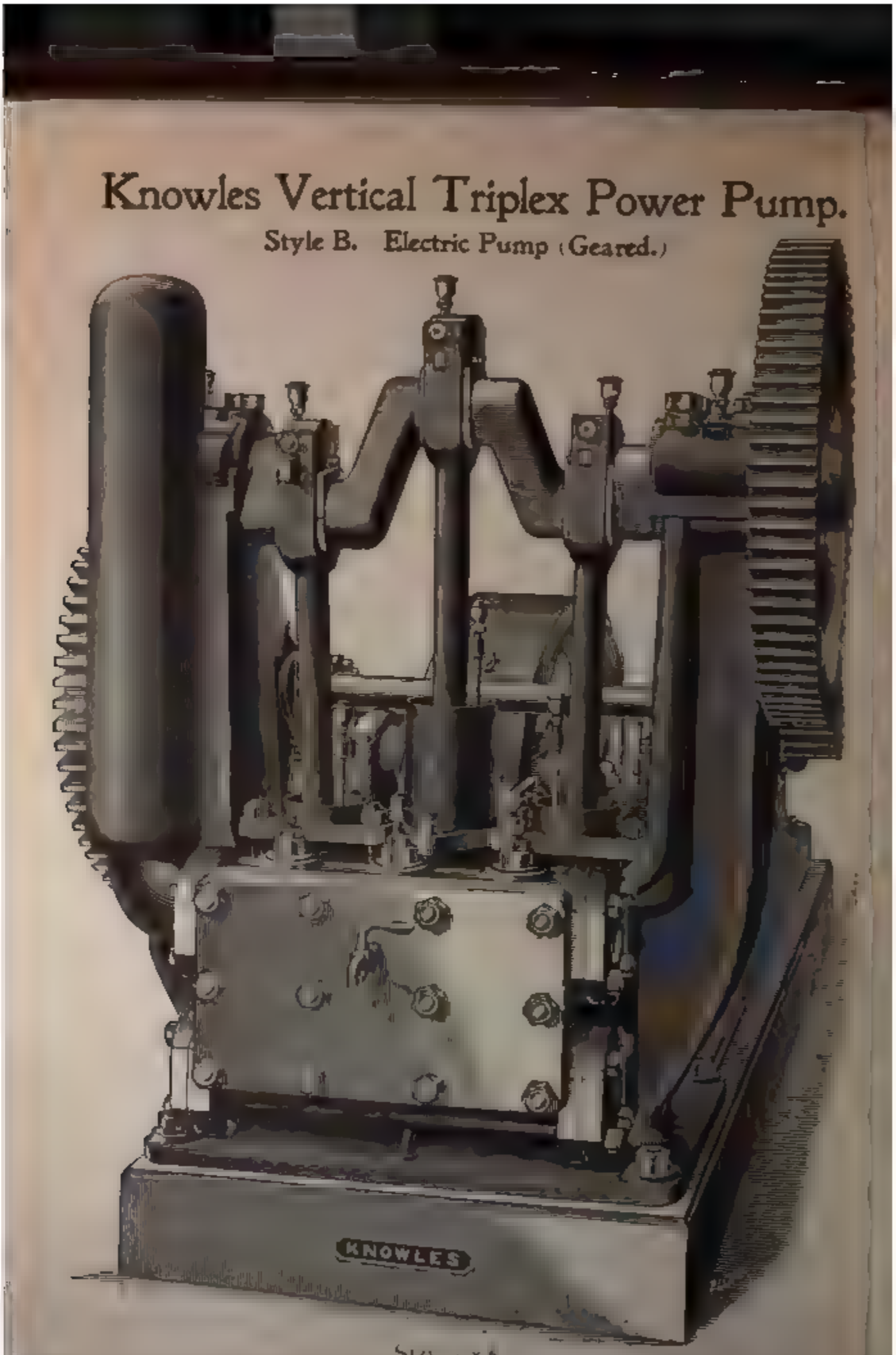
For Illustrations and List of Sizes see Pages 10, 12 and 13.

THE great advantages possessed by triplex power pumps over those of the single or duplex type, where a steady and continuous discharge is desired, either for producing an even hydraulic pressure, or for preventing water-hammer and unpleasant vibration for elevator or other service in which entire absence of noise is desirable, is fully recognized by our best engineers. Even where the adoption of this type is not a necessity for these reasons, its easy running qualities and entire absence of "pound" or jar on piping and foundations recommend its adoption in the majority of cases where the service is particularly severe, and where the first cost is not an objection in view of the greater durability, and where final economy is considered. It is strictly a high-grade, well-designed, and exceptionally well-built pump, with smoothly operating driving parts and large valve areas. These pumps are arranged so that either the suction or discharge openings, or both, may be located on either side of the apparatus—often a point of considerable advantage in crowded locations. While every part is designed to secure the utmost compactness, the valve chambers are arranged so as to allow easy access for inspection or repair. The crank shaft is in one piece and runs in babbitted bearings. Connecting rods have adjustable babbitted boxes secured by keys, and lower ends are held in plungers by steel pins working in brass bushings in the solid ends of the rods. The gears are cut, and the plungers are packed from the outside, so any leakage may be readily detected. Both suction and discharge valves can be examined by removing one cover. The extended bed-plate for the electric type is designed especially to receive the specified type and size of motor. A pinion of fibre will be furnished for the armature shaft, so as to reduce the noise to a minimum, if specially ordered, at extra price; otherwise a cast-iron cut pinion will be furnished. All material is of the highest grade, and great care is taken in the test to prove there is no defect. The sizes in upper table are suited for pressures up to 150 pounds, those in lower table for 160 to 180 pounds. In sending inquiries or orders, always state the water pressure.

NOTE.—Each pump is furnished with tight and loose pulleys, and discharge air chamber is furnished for size 5 x 6 and larger sizes.

Knowles Vertical Triplex Power Pump.

Style B. Electric Pump (Geared.)

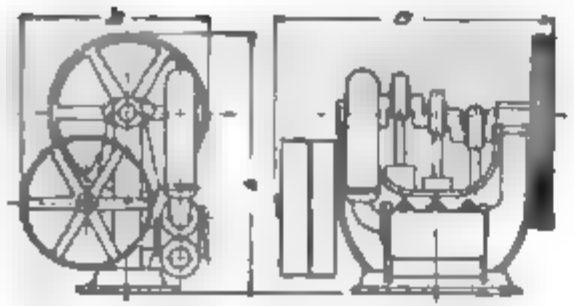


Size, 5 x 6

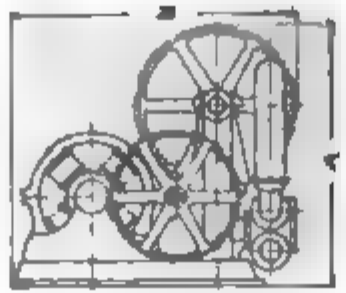
Sizes up to 4 x 6, inclusive, have outside guided plungers same as in Illustration of Style C, on page 14, and the hollow frame is used as an air chamber.

Knowles Vertical Triplex Pumps—Style "B."

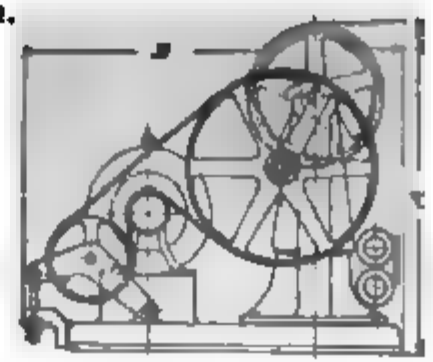
For Description see Page 11. For Illustrations see Pages 10 and 12.



Triplex Power Pumps (Belt Driven)
300 ft Lift Style "B."



Triplex Electric Pumps (Geared)
300 ft. Lift. Style "B."

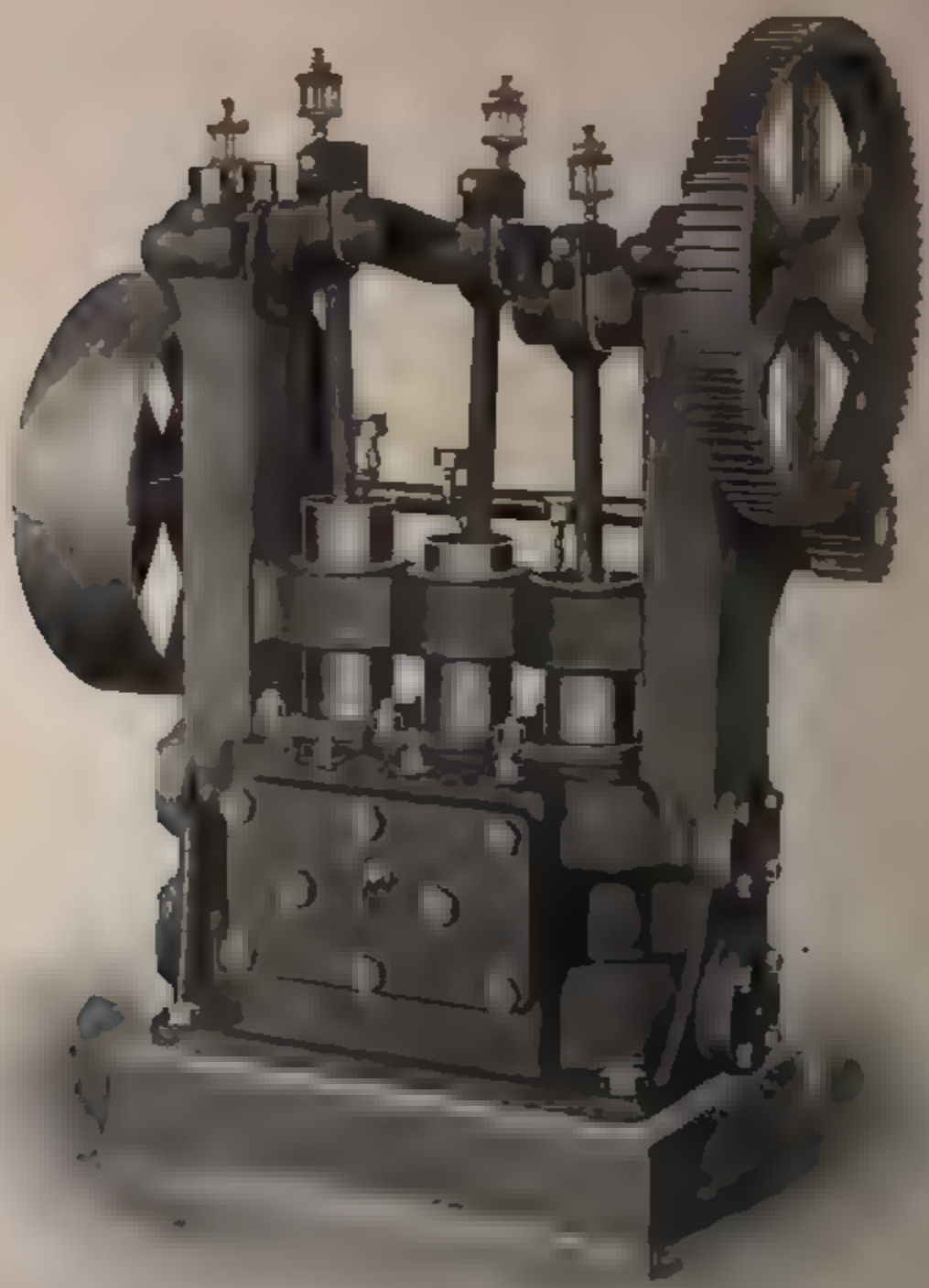


Triplex Electric Pumps (Close Belted)
300 ft. Lift. Style "B."

Diameter of Plungers	Stroke	Revs. per Min.	Gallons per Revolution.	Gallons per Minute.	Pulleys, Tight and Loose: Suction.	Pulleys, Tight and Loose: Discharge.	Pulleys, Tight and Loose: Diam	Pulleys, Tight and Loose: Face	Ratio of Pump Gears.	Ratio of Motor Gears.	H. P. Motor Required.	Dimensions Over All. Belted Pumps (Not Arranged for Motor: A	B	C	Dimensions Over All Arranged for Motor. Geared: A	B	C	Dimensions Over All Arranged for Motor Close Belted.: A	B	C	Telegraphic Code Word: Belted Pumps Not Arranged for Motor	Electric Pumps, Geared, Arranged for Motor.	Electric Pumps, Close Belted Arranged for Motor
3½	4	60	.2503	12.50	1½	1½	15	3	5 to 1		1½	32½	18¼	27⅞	34½	33	24⅞	36	30⅞	26	Dagger	Decade	Defailure
4	4	45	.3071	10.53	1½	1½	15	3	5 to 1		3	32⅝	18¼	31⅞	34½	40	30	36	43	31	Dainty	Decamp	Defaisans
4	4	45	.6628	29.37	2	2	20	3	5 to 1		3	43½	25½	38¼	47¾	45	35	47¾	45	39	Dairy	Decay	Defaisant
4	6	30	.9757	30.15	2	2	20	3	5 to 1		5	43½	25½	38¼	47¾	45	35	47¾	45	39	Dahlia	Deceit	Defaisons
4½	6	30	1.230	40.57	3	3	25	4	5 to 1		5	43½	35	40½	52¼	52	40½	52¼	53	40½	Daintily	Deceiver	Defaites
5	6	30	1.530	61.20	3	3	30	4	5 to 1		7½	43½	35	40½	52¼	52	40½	52¼	53	40½	Daily	Decease	Defalcate
5	8	30	2.040	81.60	3	3	30	5	5 to 1		10	43½	37	48½	52¼	57	40½				Damask	Decoy	
5½	8	30	2.305	92.73	4	4	30	5	5 to 1		12½	50	42½	62¼	63	64½	54				Damaskeen	Decoyed	
6	8	30	2.937	117.50	4	4	30	6	5 to 1		15	50	42½	62¼	63	64½	54				Dammable	Decoying	
6½	8	30	3.445	137.92	4	4	30	6	5 to 1		15	50	42½	62¼	63	64	54				Damper	Decree	
7	8	30	3.968	159.04	4	4	30	6	5 to 1		20	50	42¼	63¼	63	66	54				Dampish	Decrepit	
8	8	30	5.222	208.88	5	4	30	6	5 to 1		20	62	52	71	68	68	61¼				Damsel	Deface	
8	10	30	6.525	261.00	5	4	42	6	5 to 1		25	72	55	72	80	75	61				Dander	Defame	
9	10	30	8.262	330.48	6	5	42	6	5 to 1		35	80	58	80	85	75	61				Dandriv	Defacing	
SIZES BELOW ARE FOR 150 TO 180 LBS. PRESSURE.																							
3¼	4	40	.2084	8.336	1½	1½	15	3	5 to 1		3	32½	18¼	31⅞	34½	40	30	36	43	31	Dandruff	Defacingly	Defanato
3¼	4	40	.2300	9.200	1½	1½	15	3	5 to 1		3	32½	18¼	31⅞	34½	40	30	36	43	31	Danegeld	Defaconner	Defanatus
3¾	6	30	.3962	23.848	2	2	20	3	5 to 1		5	43½	25½	38¼	47¾	45	35	47¾	45	39	Danewort	Defaecabas	Defarder
4	6	40	.9787	39.15	3	3	20	4	5 to 1	To Suit Speed of Motor	7	48½	35	40½	52¼	52	40½	52¼	55	40½	Danger	Defaecando	Defatigano
4	6	40	1.530	61.20	3	3	30	5	5 to 1		10	48½	37	48½	52¾	49¾	40½	52¼	56	41	Dangerous	Defaecares	Defatigare
4½	8	40	2.037	117.50	4	4	30	6	5 to 1		20	50	42½	62¼	63	64½	54				Dangle	Defaecas	
5	8	40	3.908	159.04	4	4	30	6	5 to 1		25	62	52	71	68	68	61¾				Danish	Defaeco	
5½	8	40	5.222	208.88	5	4	42	6	5 to 1		35	66	52	71	68	68	61¼				Daphnia	Defatlir	

Knowles Vertical Triplex Power Pump.

Style C. Belted Pump.



SIZE, 4 x 4

The engraving above represents the type of sizes up to 4 x 6, inclusive.

Knowles Vertical Triplex Pumps—Style "C."

For Illustrations and List of Sizes see Pages 14, 16 and 17.

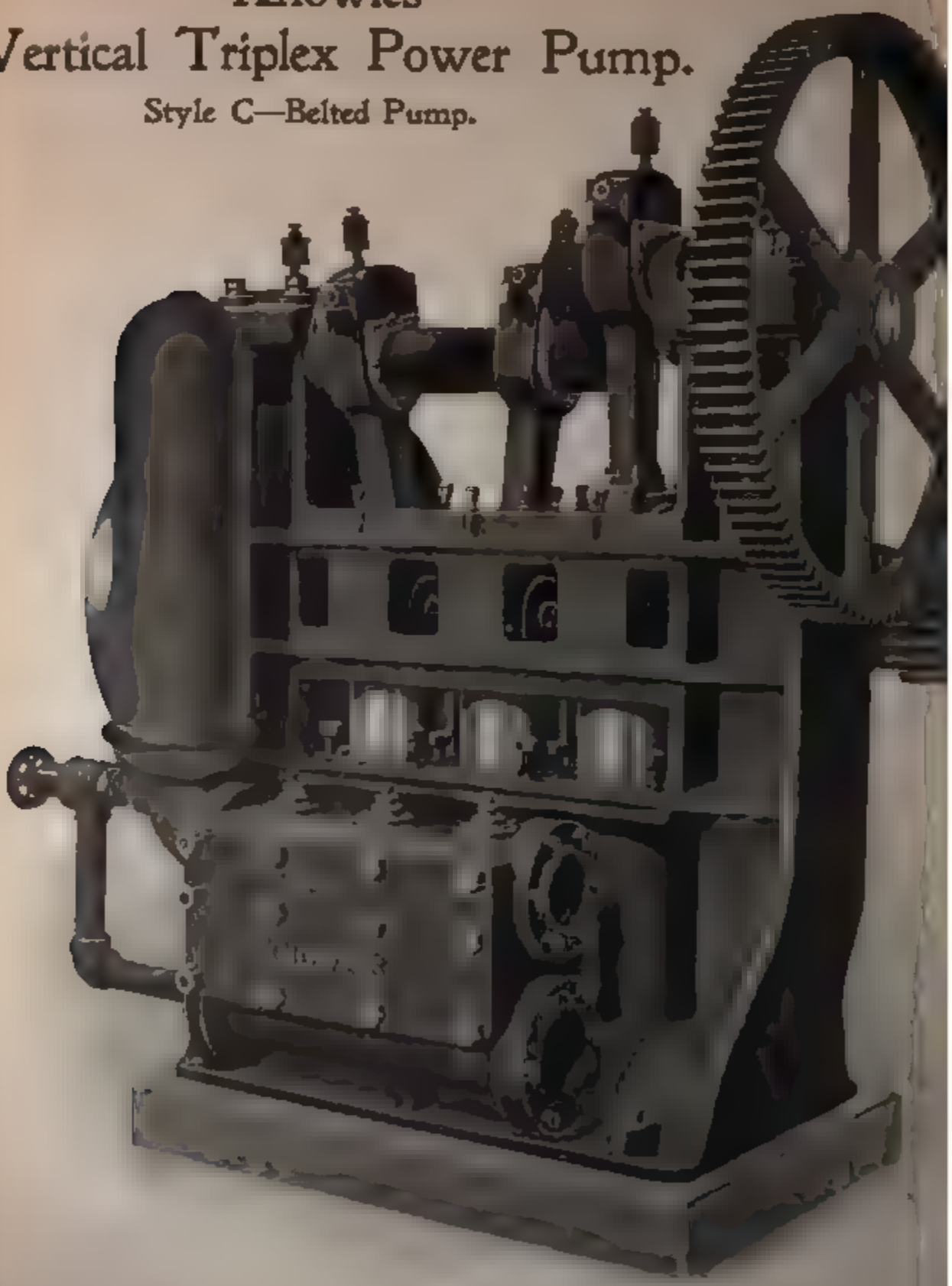
THIS style of power pump is best adapted for situations where the service is particularly severe. The main frame is of exceptional strength and rigidity, onstructed as to form guides for the plungers. The plungers are packed from outside, the valves can be easily examined, the throat linings replaced when n, and wearing parts can be taken up. The plungers have outside guided sheads which sustain the side thrust of the connecting rods. By this con-:tion the wear of the plungers, glands, and packing is reduced to a minimum. connecting rods have babbitted boxes, made in halves, with key adjustment ank end, crosshead end being solid with brass bushing. All gears are cut. pumps are arranged so that either the suction or discharge, or both, may be l on either side of the apparatus. The valves can be fitted for hot or cold Both suction and discharge valves can be examined by removing one The extended bed-plate, for the electric type, is designed especially to the specified type and size of motor. A pinion of fibre will be furnished armature shaft, so as to reduce the noise to a minimum, if specially at extra price; otherwise a cast-iron cut pinion will be furnished. All s of the highest grade, and great care is taken in the test to prove there ct.

izes in upper table are suited for pressures up to 150 pounds, those in for 160 to 180 pounds. In sending inquiries or orders, always state ressure.

-Each pump is furnished with tight and loose pulleys, and discharge is furnished for size 5 x 6 and larger sizes.

Knowles
Vertical Triplex Power Pump.

Style C—Belted Pump.

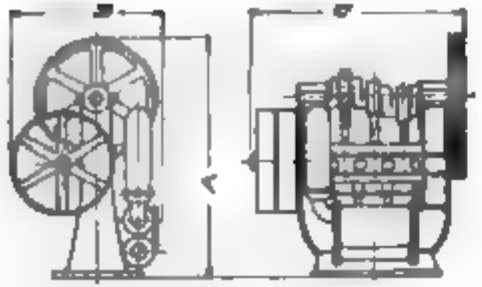


SIZE, 5 x 5

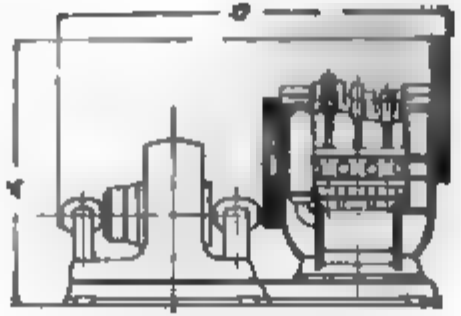
The engraving above represents the type for sizes 4½ x 6 and larger. The *pipe and relief valve shown are furnished only when specially* **ordered, and at additional price.**

Knowles Vertical Triplex Pumps - Style "C."

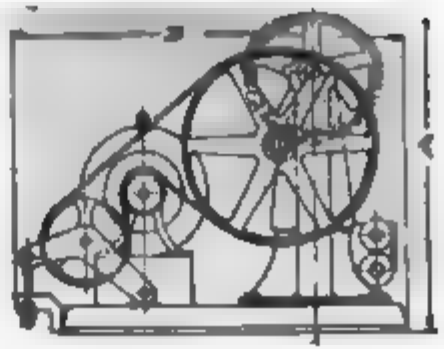
For Description see Page 15. For Illustrations see Pages 14 and 16.



Triplex Power Pumps (Belt Driven). 300 ft. Lift. Style "C."



Triplex Electric Pumps (Geared). 300 ft. Lift. Style "C."



Triplex Electric Pumps (Close Belted). 300 ft. Lift. Style "C."

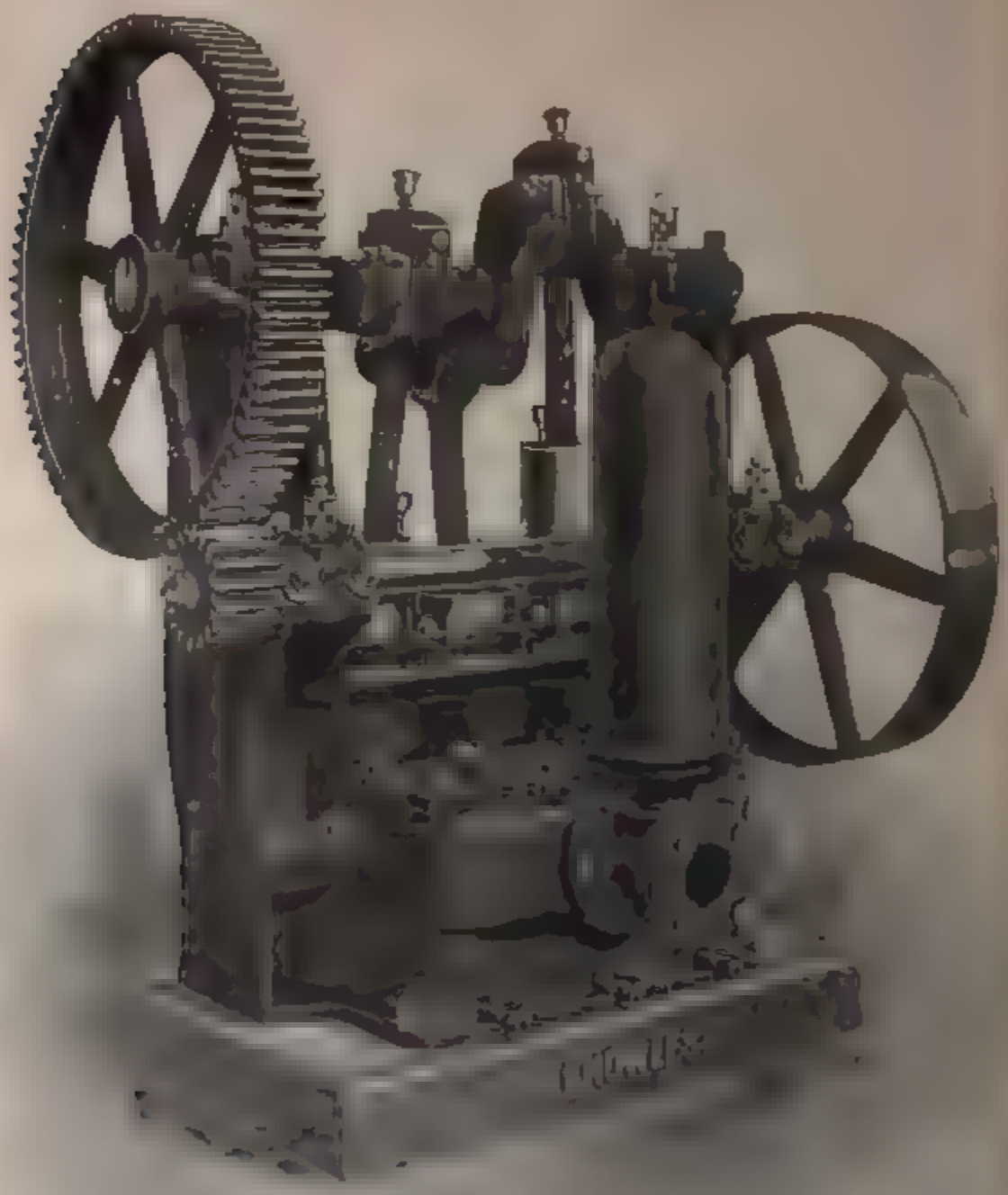
Diameter of Plungers	Stroke	Revs. per Min.	Gallons per Revolution	Gallons per Minute.	Pulleys, Tight and Loose: Suction	Pulleys, Tight and Loose: Discharge	Pulleys, Tight and Loose: Diam.	Pulleys, Tight and Loose: Face	Ratio of Pump Gears.	Ratio of Motor Gears	H. P. Motor Required.	Dimensions Over All Belted Pumps Not Arranged for Motor. A	B	C	Dimensions Over All Arranged for Motor Geared. A	B	C	Dimensions Over All Arranged for Motor. Close Belted. A	B	C	Telegraphic Code Word. Belted Pumps Not Arranged for Motor	Electric Pumps, Geared, Arranged for Motor	Electric Pumps Close, Belted Arranged for Motor.
2½	4	450	.1540	13.90	1½	1½	15	3	5 to 1	To Suit Speed of Motor	1½	32½	18¼	27½	31½	30¼	50	35½	39½	36	Fabian	Facetmore	Macaghe
3	4	445	.3573	16.53	1½	1½	15	3	5 to 1		3	32½	18¼	31½	34½	29¼	51	32¼	43	31	Fabled	Facetious	Macagua
4	4	445	.6535	24.37	2	2	20	3	5 to 1		5	43½	25½	38¼	47½	32	62	47¼	45	39	Fabricate	Facial	Macahalat
4½	6	440	.4787	30.15	2	2	20	3	5 to 1		5	43½	25½	38¼	47¼	37	71	47¼	45	39	Fabrile	Facule	Macairien
4½	6	440	1.239	40.57	3	3	20	4	5 to 1		7	51	35	40¾	50	42½	82⅝	50	55	41	Fabulate	Faculely	Macairisme
5	6	440	1.530	50.20	3	3	20	4	5 to 1		7	51	35	40¾	50	42⅝	82⅝	59	55	41	Fabulist	Facultate	Macaiste
5½	8	440	2.010	81.60	3	3	20	5	5 to 1		10	60	38	40	63	45	85½				Fabulous	Facility	
6	8	440	2.469	96.73	4	4	20	5	5 to 1		12½	71¼	43½	62¼	70¼	54	100				Fabulously	Facingly	
6	8	440	2.937	117.50	4	4	20	5	5 to 1		15	71¼	43½	62¼	70¼	54	106				Faburden	Fackel	
6½	8	440	3.419	137.92	4	4	20	5	5 to 1		15	71¼	43½	62¼	70¼	54	106				Facade	Faction	
7	8	440	3.908	159.04	4	4	20	6	5 to 1		20	76½	50	71	81½	56	114¾				Facanea	Factional	
8	8	440	5.222	208.88	5	4	20	6	5 to 1		20	76½	52	71	81½	60	114¾				Faceless	Factionary	
9	10	440	6.525	261.00	5	4	42	6	5 to 1		25	81½	57½	71	88	68	135				Faceted	Factious	
10	10	440	8.202	330.48	5	5	42	6	5 to 1		25	85	58	81	92	68	135				Facetely	Mabillon	

SIZES BELOW ARE FOR 100 TO 150 LBS. PRESSURE.

2½	4	440	.2064	8.250	1½	1½	15	3	5 to 1	To Suit Speed of Motor	3	32½	18¼	31½	34½	29¼	51	34¼	43	31	Faceteness	Mahuja	Macarenlis
3	4	440	.2300	9.200	1½	1½	15	3	5 to 1		3	32½	18¼	31½	34½	29¼	51	34¼	43	31	Facetiabor	Macabre	Macarello
4	6	440	.6462	25.849	2	2	20	3	5 to 1		5	43½	25½	38¼	47¼	37	71	47¼	45	39	Facetiari	Macacheira	Macarenas
4½	6	440	.0787	30.15	3	3	20	4	5 to 1		7	51	35	40¾	50	42	82⅝	59	55	41	Facetiarum	Macacus	Macareux
5	6	440	1.530	51.20	3	3	20	4	5 to 1		10	59	38	49	63⅝	45	86½	63⅝	60	40	Facetiemur	Macadamize	Macariotes
5½	8	440	2.017	117.60	4	4	20	6	5 to 1		20	71¼	43½	62¼	70¼	54	106				Facetieux	Macadamizo	
6	8	440	3.008	159.04	4	4	20	6	5 to 1		25	76½	52	71	81½	56	114¾				Facetiner	Macadura	
7	8	440	5.222	208.88	5	4	42	6	5 to 1		25	76½	52	71	81½	59	114¾				Faceting	Macagatos	

Knowles Vertical Triplex Power Pump.

Style E—Belted Pump.



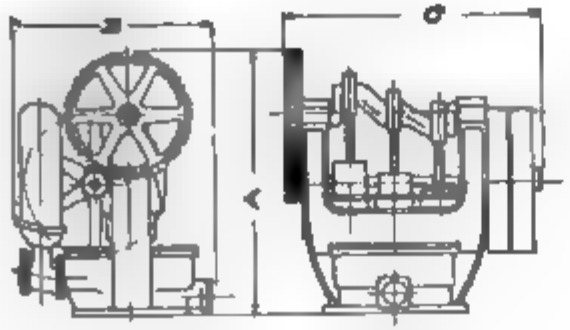
SIZE 8 x 8.

(Smaller sizes have cylinders and frame cast in one piece.)

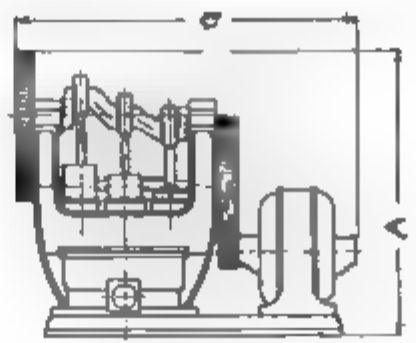
Pumps are fitted with Tight and Loose Pulleys.

Knowles Vertical Triplex Pumps Style E.

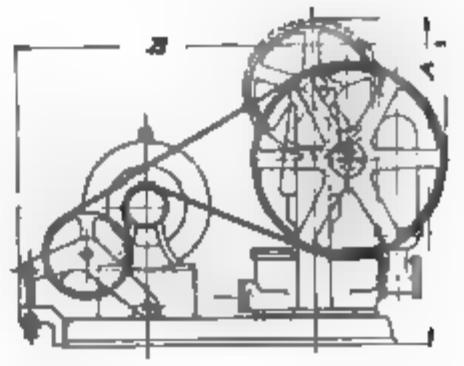
This line of power pumps is designed for light service. The plungers are outside packed, the valves can be easily examined. The crank shaft is in one piece working in babbitted bearings. All gears are cut. Connecting rods have adjustable babbitted boxes secured by keys, and lower ends are held to plungers by steel pins working in brass bushings in the solid ends of the rods. Each pump is furnished with tight and loose pulleys, and discharge air chamber and has suction and discharge openings on opposite sides. The extended bed-plate for the electric type is designed especially to receive the specified type and size of motor. A pinion of fibre will be furnished on the armature shaft, so as to reduce the noise to a minimum, if specially ordered at extra price; otherwise a cast iron cut pinion will be furnished. All material is of the highest grade, and great care is taken in the test to prove there is no defect. The sizes in the following table are suited for 100 ft. lift. In sending inquiries or orders, always state the water pressure.



Triplex Power Pumps (Belt Driven) 100 ft. Lift. Style "B"



Triplex Electric Pumps (Geared) 100 ft. Lift. Style "E"

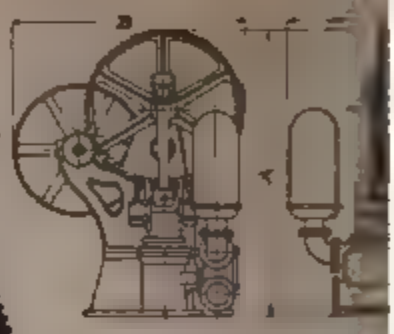


Triplex Electric Pumps (Close Belted) 100 ft. Lift. Style "E"

Diameter of Plungers.	Stroke.	Revs. per Min.	Gallons per Revolution.	Gallons per Minute.	Suction	Discharge	Pulleys Tight and Loose — Diam.	Pulleys Tight and Loose — Face.	Pattern of Pump Gears	Rated Motor Gear. H. P. Motor Required.	Dimensions Over All Belted Pumps Not Arranged for Motor. A	B	C	Dimensions Over All Arranged for Motor Geared A	B	C	Dimensions Over All Arranged for Motor, Close Belted A	B	C	Telegraphic Code Word — Belted Pumps Not Arranged for Motor.	Electric Pumps, Geared Arranged for Motor	Electric Pump Close Belted Arranged for Motor
4	6	150	.0524	7.87	2	2	20	3	5 to 1	1½	38¼	28½	34⅞	42½	30	51	42½	51⅜	34	Factive	Fading	Macaw
4	6	240	.1745	41.88	2	2	20	3	4 to 1	2	38¼	28½	41	42½	30	52	42¼	54½	34	Factorage	Fagging	Macbeth
4	6	340	1.530	91 80	3	3	20	4	4 to 1	3	45¼	31	43½	49½	41	61¼	49½	64	42	Factotum	Fagot	Maccabeus
5	6	340	2.030	81 60	3	3	20	4	4 to 1	4	45¼	31⅝	43½	49½	41	67				Factual	Failing	
5	8	340	3.448	137 02	4	4	26	5	4 to 1	7	47¼	34¼	51¼	51¼	45	74				Facture	Failure	
6	8	340	3.098	150 32	4	4	30	5	4¼ to 1	8	55	33	51	60	47	80				Faculty	Fainted	
8	10	340	5 222	208 88	4	4	36	6	5 to 1	10	55	48	64	62½	48	85				Facund	Fainting	
10	10	340	6.525	261 00	5	4	36	6	5 to 1	12½	58¼	48	68	66	48	93				Faddle	Faintly	
12	10	340	7.833	313 32	5	4	36	6	5 to 1	15	62	48	68	74	48	96				Fadeless	Faintness	
10	10	480	8 262	330 48	6	5	36	6	5 to 1	17	69	50	74	174	50	100				Fadengold	Fairhood	
12	10	480	9.912	396.48	6	5	42	8	5 to 1	20	80	50	78	78	53	106				Fadengrade	Fairings	
12	12	480	12.240	489 60	8	7	42	8	5 to 1	25	84	52	80	89	53	115				Fadenkler	Fairishly	

Knowles
Vertical Triplex Power Pump.

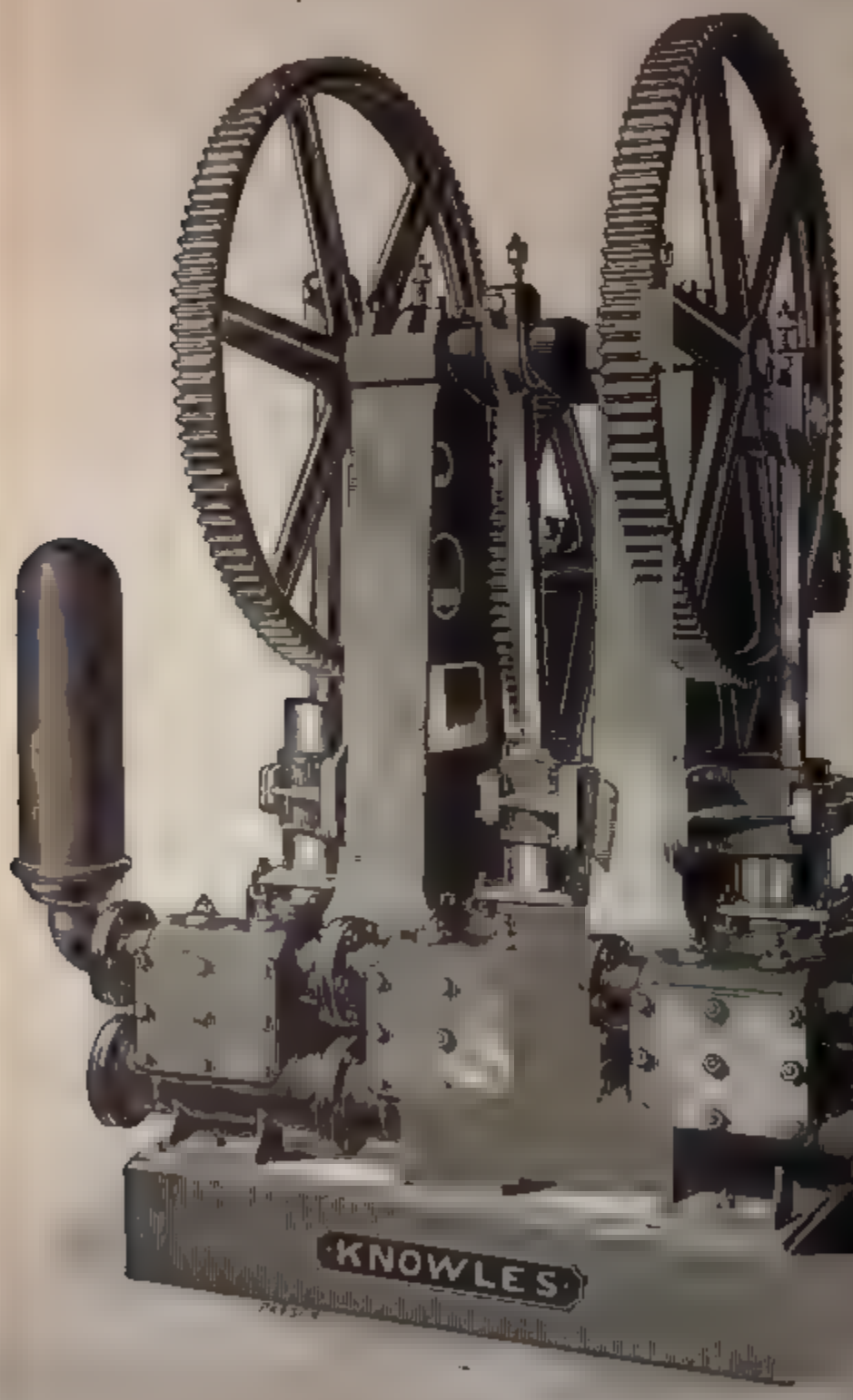
Styles A and F.



Triplex Power Pump
300 ft. Lift

Triplex Electric P
300 ft. Lift.

Triplex Pumps (S
100 ft. Lift.



Size, 8 x 12 — Style A.

Showing Extended Bed-plate for Motor. (Style F is shown by outline, de

Knowles Vertical Triplex Pumps—Styles A and F

THE cut on the opposite page shows one of the larger sizes of vertical triplex electric power pumps as it appears with extended bed-plate ready for mounting the motor. In addition to its suitability for boiler feed, hydraulic and general tank service, this pump is especially adapted for mining operations, as it is designed so as to be easily taken apart and readily put together again when necessary. Our experience in mine pumping has enabled us to embody all the essentials in this pump which insure convenience, reliability and compactness. The arrangement of cranks differs from the preceding styles of pumps in having supports for crank shaft between centre and outside cranks. This arrangement produces a smaller bending moment in the crank shaft, and is for this reason better adapted to these pumps of larger capacities. The plungers are single-acting, guided above, relieving them of excessive wear or strain, and packed from the outside, so any leakage may be readily detected. The power is transmitted direct to each of these plungers in the following manner: A countershaft behind the pump transmits the power to spur gears at either end of the pump, driving the two outside plungers by crank pins secured in gears, and at the same time driving the centre or middle plunger through the single throw crank shaft located between the supports. The steel connecting rods have babbitted boxes, made in halves with key adjustment on crank end, crosshead end being solid with brass bushing. The suction and discharge openings are on either side, a very handy arrangement where space is restricted. Each pump is furnished with a discharge air chamber. The extended bed-plate for the electric type is designed especially to receive the specified type and size of motor. A pinion of fibre will be furnished for the armature shaft, so as to reduce the noise to a minimum, if specially ordered, at extra price; otherwise a cast-iron cut pinion will be furnished. All material is of the highest grade, and great care is taken in the test to prove there is no defect. This class of pump is also made, when specially ordered, with connecting rods secured to independent crossheads attached to the upper end of plungers, crossheads being fitted with adjustable shoes in guides.

These pumps are designed for two pressures: Upper table, Style A, suitable for 150 pounds water pressure; lower table, Style F, 50 pounds water pressure. In sending inquiries or orders, always state the water pressure.

FOR 300 FEET LIFT, STYLE A.

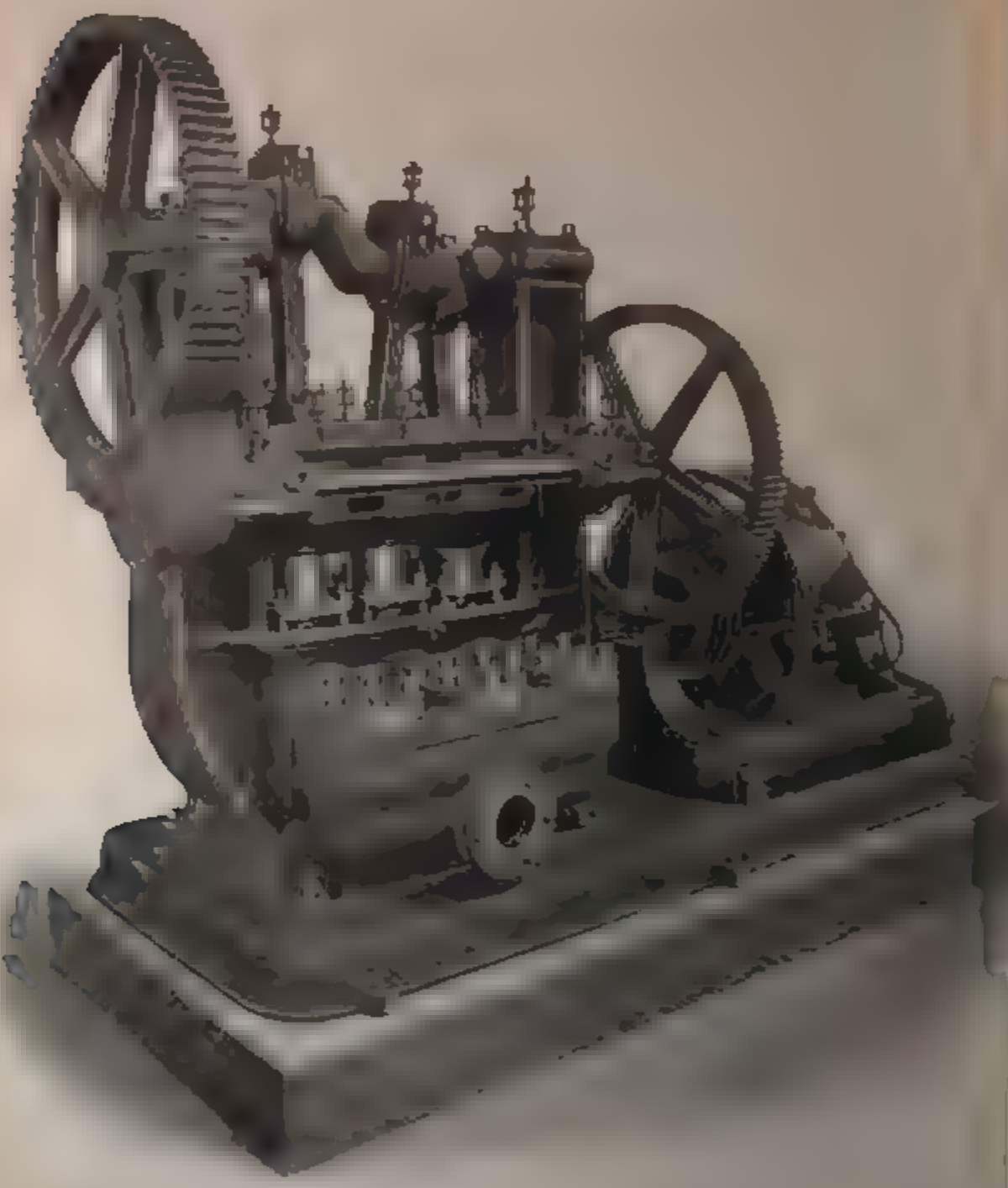
Diameter of Plungers.	Stroke.	Revolutions per Minute.	Gallons per Revolution.	Gallons per Minute.	Suction.	Discharge.	Pulleys, Tight and Loose. Diam.	Pulleys, Tight and Loose. Face.	Ratio of Pump Gears.	Ratio of Motor Gears.	H. P. Motor Required.	Dimensions Over All. Belted Pumps Not Arranged for Motor. A	B	C	Dimensions Over All Arranged for Motor Geared. A	B	C	Telegraphic Code Word. Belted Pumps Not Arranged for Motor.	Electric Pumps, Geared. Arranged for Motor.
8	12	40	7.533	314	5	4	42	6	6 to 1	To Suit Speed of Motor.	30	105	81	88	105	105	95	Dapper	Defeat
9	10	40	8.262	330	6	5	42	6	6 to 1		35	105	81	88	105	108	102	Darkly	Define
9	12	40	9.915	397	6	5	42	8	6 to 1		40	105	81	88	105	108	105	Darling	Deform
10	12	40	12.243	490	8	7	42	8	6 to 1		50	106½	81	93⅞	106½	108	107	Dastard	Defraud
							One Pulley.												
11	12	40	14.811	592	8	7	42	10	6 to 1		60	106½	81	93⅞	106½	108	108	Dauber	Deject
12	12	40	17.628	705	10	8	48	10	6 to 1		70	109½	88	97½	109½	115	112	Daunted	Deluge
13	12	40	20.685	827	10	8	48	12	6 to 1		75	109½	88	97½	109½	120	115	Dazzle	Deport

SIZES BELOW ARE FOR 100 FEET LIFT, STYLE F, TIGHT AND LOOSE PULLEYS.

9	10	40	8.262	330	6	5	30	5	5 to 1	To Suit Speed of Motor	18	82	59½	82	82	87	82	Fairly	Faithless
9	12	40	9.915	397	6	5	30	5	5 to 1		20	90	66	87	90	89	89	Fairness	Fakir
10	12	40	12.243	490	8	7	30	6	4.85 to 1		25	95	66	87	95	91	91	Fairy	Falcade
11	12	40	14.811	592	8	7	30	6	4.85 to 1		30	95	66	87	95	95	95	Fairylike	Falcated
12	12	40	17.628	705	10	8	42	8	5 to 1		35	101	78	96½	101	102	100	Faith	Falchion
13	12	40	20.685	827	10	8	42	8	5 to 1		40	101	78	96½	101	105	105	Faithful	Falcon

Knowles Vertical Triplex Power Pump.

Style G—Electric Pump (Geared.



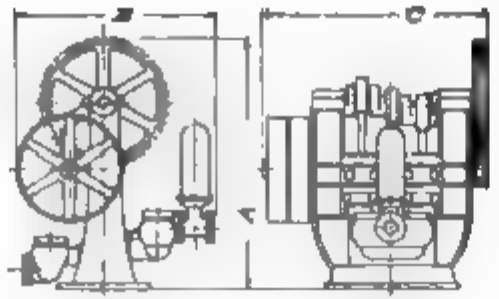
SIZE, 9 x 8 x 9.

Gear Guards furnished only when specially ordered, and at additional price.

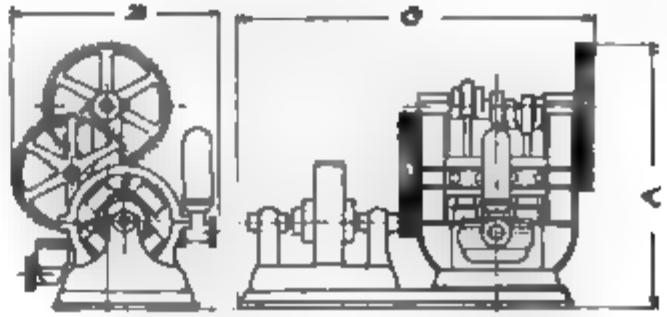
Vertical Triplex Pumps Style G.

THIS line of power pumps is particularly suited for large buildings where there is but small floor space and where freedom from water-hammer is desirable together with an unvarying pressure. The main frame is of exceptional strength and rigidity, so constructed as to form guides for the plungers. The plungers are single-acting, and being guided, perfect alignment is insured. The plungers are packed from the outside, so any leakage may be readily detected. The valve chambers are of the "pot" type, there being one valve in each compartment, this making a very strong and light construction. The removal of a pot cover gives access to its valve without disturbing any of the other valves. The crank shaft is in one piece, working in babbitted bearings. All gears are cut, thus increasing smoothness of action and life of pump. Connecting rods have adjustable babbitted boxes secured by keys, and lower ends are held in plungers by steel pins working in brass bushings in the solid ends of the rods. Each pump is furnished with tight and loose pulleys, and discharge air chamber and has ample suction and discharge openings on opposite sides. The extended bed-plate, for the electric type, is designed especially to receive the specified type and size of motor. A pinion of fibre will be furnished for the armature shaft so as to reduce the noise to a minimum, if specially ordered, at extra price, otherwise a cast-iron cut pinion will be furnished. All material is of the highest grade, and great care is taken in the test to prove there is no defect.

The sizes in the following table are suited for a pressure of 200 to 300 pounds. In sending inquiries or orders always state the water pressure.

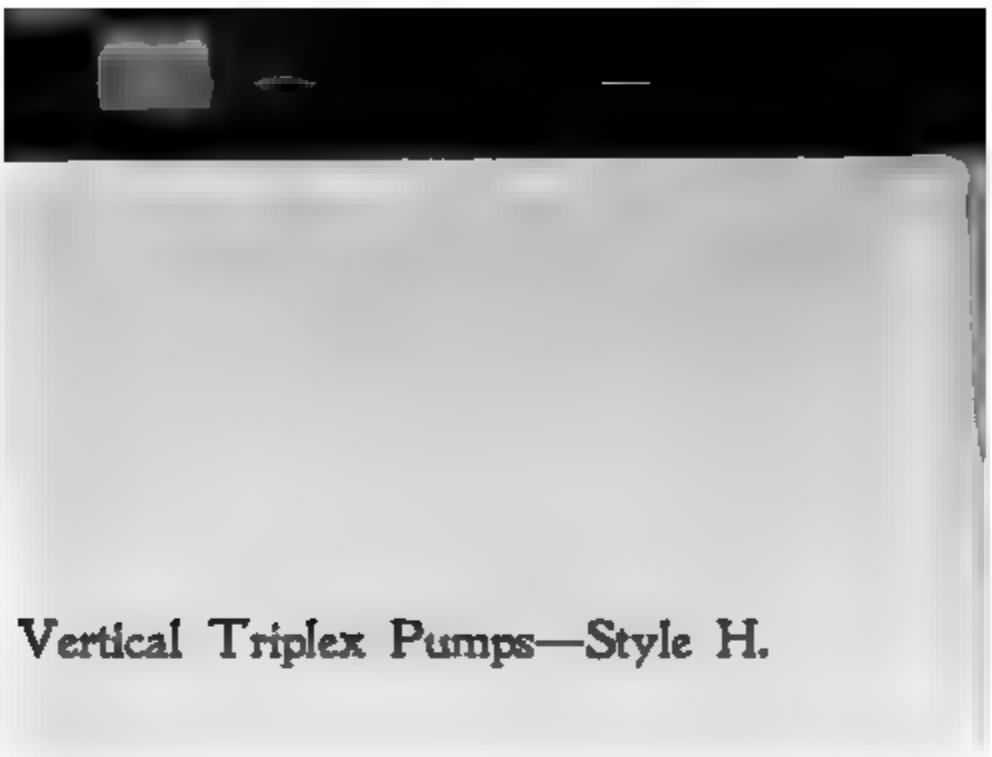


Triplex Power Pumps (Belt Driven) 500 to 600 ft. Lift. Style G.



Triplex Electric Pumps (Geared). 500 to 600 ft. Lift. Style G

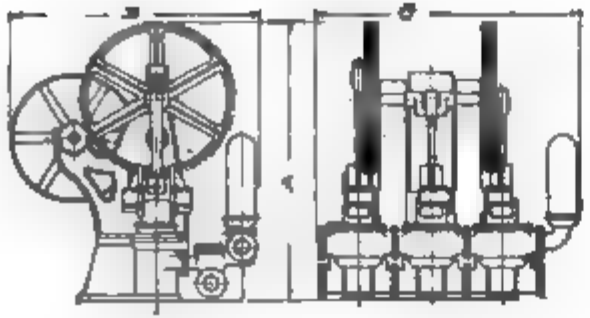
Diameter of Plungers.	Stroke.	Revolutions per Minute	Gallons per Revolution.	Gallons per Minute	Pulleys, Tight and Loose. Suction	Pulleys, Tight and Loose. Discharge	Pulleys, Tight and Loose. Diam	Pulleys, Tight and Loose. Face.	Ratio of Pump Gears.	Ratio of Motor Gears.	H P Motor Required	Dimensions Over All Belted Pumps Not Arranged for Motor. A	Dimensions Over All Belted Pumps Not Arranged for Motor. B	Dimensions Over All Belted Pumps Not Arranged for Motor. C	Dimensions Over All Arranged for Motor, Geared. A	Dimensions Over All Arranged for Motor, Geared. B	Dimensions Over All Arranged for Motor, Geared. C	Telegraphic Code Words. Belted Pumps Not Arranged for Motor	Telegraphic Code Words. Electric Pumps Geared Arranged for Motor
3	4	45	.0673	10.53	1¼	1¼	30	3	5 to 1	To Suit Speed of Motor.	8	30¾	26½	37¼	40¾	26¾	60	Falconet	Falsely
4	4	45	.0628	20.37	2	2	35	4	5 to 1		10	54	42	47	59	43	75	Fallacy	Falseness
4	4	40	.0747	31.15	2	2	30	5	5 to 1		10	54	43	50	59	43	80	Fallen	Falsetto
4	5	40	1.305	52.20	2	2	30	5	5 to 1		12	62	48	50	67	48	85	Fallible	Falsify
5	6	40	1.530	61.20	3	3	30	5	5 to 1		15	72	55	62	77	55	97	Falling	Falter
5	6	40	2.040	81.60	3	3	30	6	5 to 1		20	72	58	64	77	58	100	Fallow	Faltered
5½	8	40	2.468	98.73	4	4	42	6	5 to 1		25	72	61	66	77	58	105	Fallsack	Falterer
6½	8	40	3.448	137.92	4	4	42	6	5 to 1		35	76½	64	71	77	68	115	Falsehood	Faltering



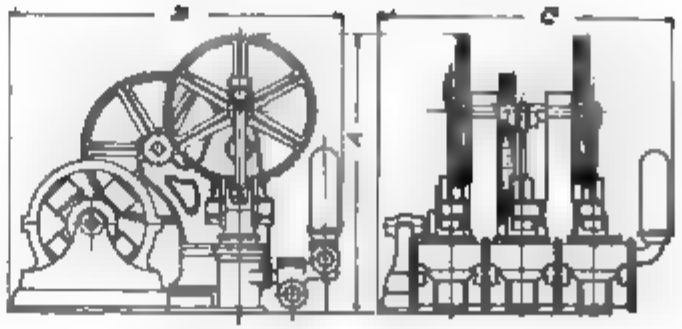
Knowles Vertical Triplex Pumps—Style H.

THIS line of power pumps is designed for the same purposes as Style G, differing only in construction, the change being made on account of it not being practical to make the same design as Style G, for the larger sizes. The plungers are single-acting, guided above, and outside packed. The crank shaft is in one piece, working in babbitted bearings, supported between centre and outside cranks. The power is transmitted direct to the plungers in the manner spoken of in description of Styles A and F. Connecting rods are steel, having babbitted boxes on crank end with key adjustment, crosshead end being solid with brass bushing. Each pump is furnished with tight pulley and discharge air chamber, and has ample suction and discharge openings on either side. The valve chambers are of the "pot" type with a cover over each valve. By this arrangement access to any valve desired is made easy without disturbing the others. All gears are cut. The extended bed-plate, for the electric type, is designed especially to receive the specified type and size of motor. A pinion of fibre will be furnished for the armature shaft, so as to reduce the noise to a minimum, if specially ordered, at extra price; otherwise a cast-iron cut pinion will be furnished. All material is of the highest grade, and great care is taken in the test to prove there is no defect. The sizes in the following table are suited for a pressure of 250 to 300 pounds. In sending inquiries or orders, always state the water pressure.

Knowles Vertical Triplex Pumps—*Style H.*



Triplex Power Pumps (Belt Driven)
500 to 600 ft. Lift. Style H.

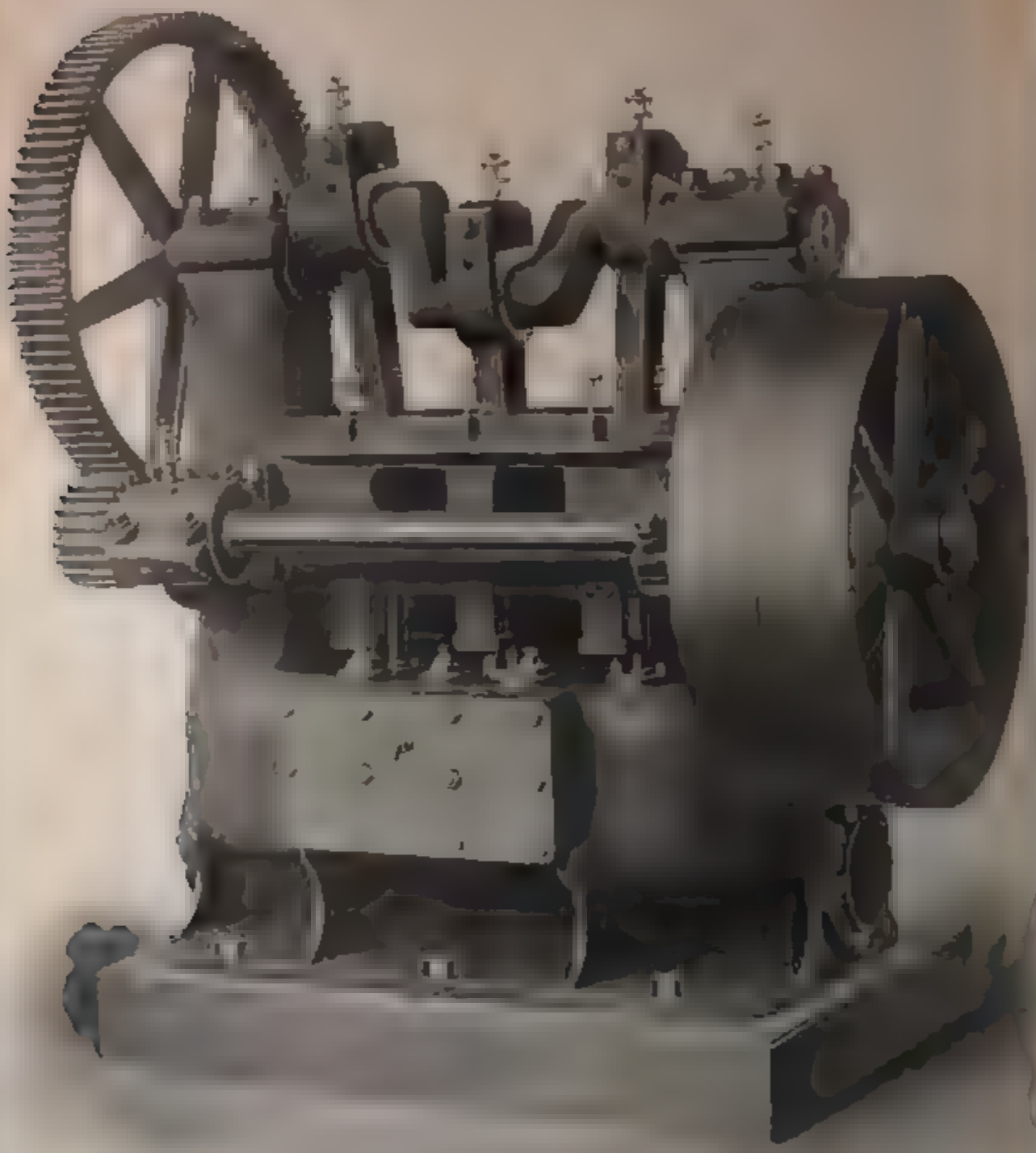


Triplex Electric Pumps (Geared).
500 to 600 ft. Lift. Style H.

Diameter of Plungers.	Stroke	Revolutions per Minute.	Gallons per Revolution.	Gallons per Minute	Suction.	Discharge	Pulley. Diam	Pulley. Face.	Ratio of Pump Gears.	Ratio of Motor Gears	H P Motor Required.	Dimensions Over All. Belted Pumps Not Arranged for Motor A	B	C	Dimensions Over All Arranged for Motor. Geared. A	B	C	Telegraphic Code Word. Belted Pumps Not Arranged for Motor.	Electric Pumps. Geared. Arranged for Motor.
6	10	40	5.00	200	5	4	42	8	6 to 1	To Suit Speed of Motor	50	105	87	88	105	108	107	Fameless	Famine
6½	10	40	6.52	261	5	4	42	10	6 to 1		65	107	89	96	107	114	107	Familiar	Famish
8	12	40	7.83	314	5	4	48	12	6 to 1		80	110	96	96	110	118	112	Family	Famished

Knowles Vertical Triplex Power Pump.

Style "I," Type No. 1.



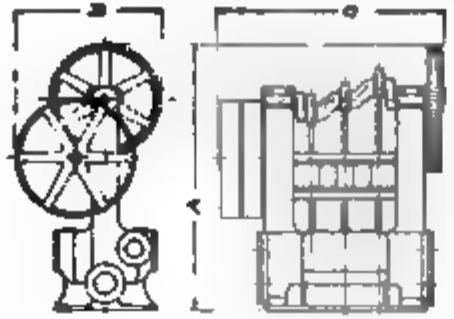
Belted Pump. Double-Acting Piston Pattern.

SIZE, 7 x 5.

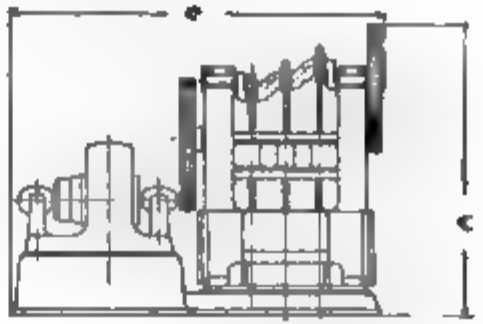
Knowles Vertical Triplex Pumps—Style "I," Type No.

Double-Acting Piston Pattern.

IN construction this pump differs slightly from Style "I," Type No. 2, it having the valve chests and crosshead guides cast with the frame, the latter being also somewhat different style. Valve chests are located on front and back of pump and are furnished with large handhole plates, the removal of which gives access to valves. The crosshead guides being cast with the frame form a tie, thereby making the pump of exceptional strength and rigidity. The crank shaft is in one piece, working in babbitted bearings. All gears are cut, thus increasing smoothness of action and life of pump. Connecting rods are of steel having babbitted boxes, made in halves with key adjustment on crank end, crosshead end being solid with brass bushings. Belted pumps are furnished with tight and loose pulleys. Ample suction and discharge openings are located on either side. The hollow frame is utilized as a discharge air chamber. The removal of the upper pump cylinder head gives access to piston when adjustment is required. The extended bed-plate, for the electric type, is designed especially to receive the specified type and size of motor. A pinion of fibre will be furnished for the armature shaft, so as to reduce the noise to a minimum, if specially ordered, at extra price; otherwise a cast-iron cut pinion will be furnished. All material is of the highest grade, and great care is taken in the test to prove there is no defect. The sizes in upper table are suited for a pressure of 100 pounds, in lower table for a pressure of 130 pounds. In sending inquiries or orders, always state as fully as possible the intended service and requirements.



Triplex Power Pumps (Belt Driven)
Double-Acting Piston Pattern. Style "I," Type No. 1.



Triplex Electric Pumps (Geared).
Double-Acting Piston Pattern. Style "I," Type No. 1.

FOR 100 LBS. PRESSURE.

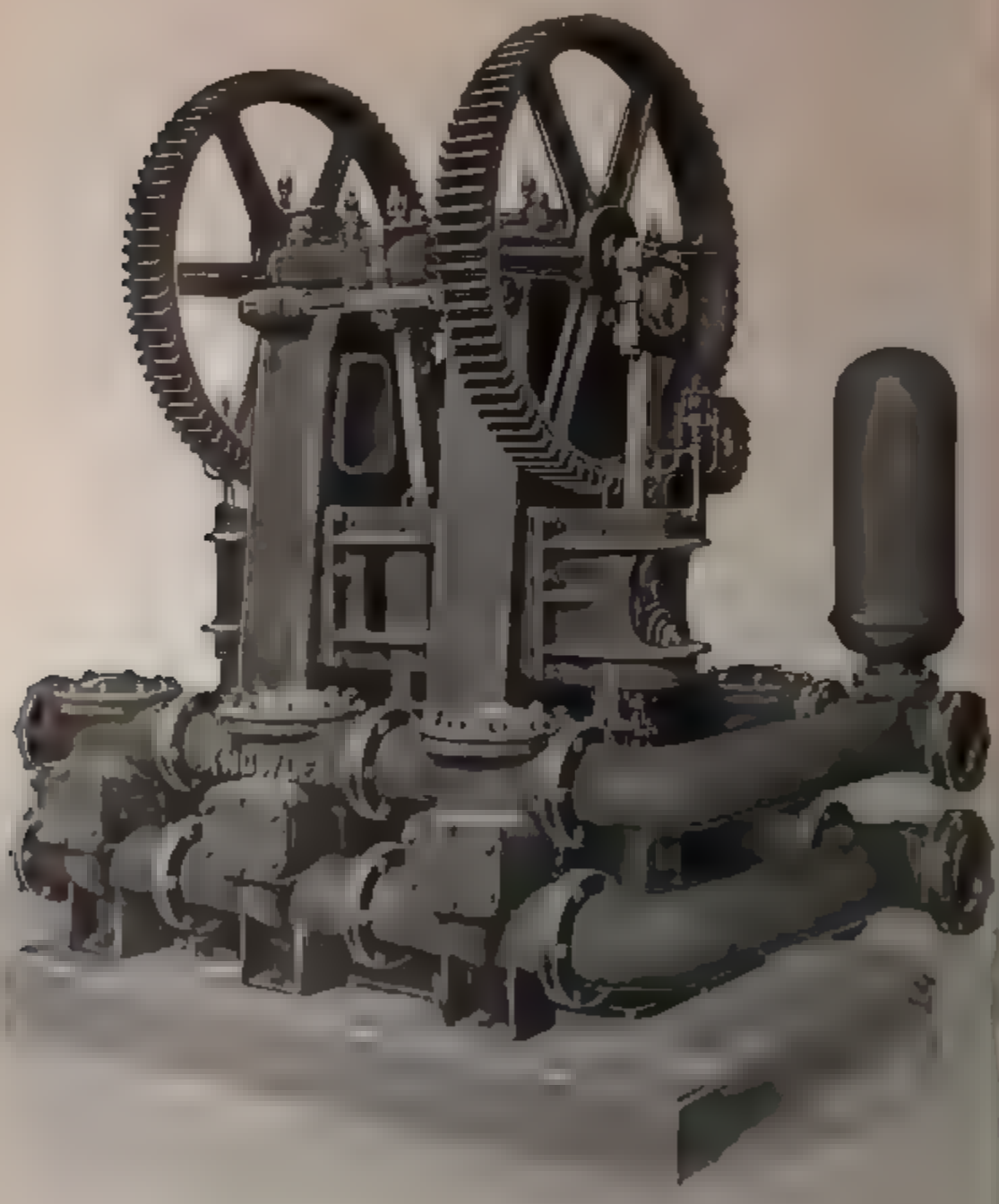
Diameter of Pistons.	Stroke.	Revolutions per Minute.	Gallons per Revolution.	Gallons per Minute.	Suction.	Discharge.	Pulleys, Tight and Loose. Diam.	Face.	Ratio of Pump Gears.	Ratio of Motor Gears.	H P Motor Required.	Dimensions Over All Belted Pumps Not Arranged for Motor. A	B	C	Dimensions Over All, Arranged for Motor, Geared. A	B	C	Telegraphic Code Word. Belted Pumps Not Arranged for Motor.	Electric Pumps, Geared, Arranged for Motor.
[illegible]	8	45	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5 to 1	To Suit Speed of Motor	25	6' 3"	3' 8"	5' 0"	6' 10"	4' 8"	9' 10"	Mailath	Mailiot
[illegible]	8	45	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5 to 1		30	6' 3"	3' 11"	5' 0"	6' 10"	5' 0"	9' 10"	Mailaub	Maillotin
[illegible]	8	45	[illegible]	[illegible]	7	6	36	6	5 to 1		35	6' 3"	3' 11"	6' 0"	6' 10"	5' 0"	10' 4"	Mailuch	Mailuft

SIZES BELOW ARE FOR 130 LBS. PRESSURE.

6½	8	45	6.98	330	[illegible]	[illegible]	42	6	5 to 1	To Suit Speed of Motor	40	6' 5"	4' 6"	6' 0"	7' 0"	5' 6"	10' 4"	Mainata	Mainained
[illegible]	8	45	[illegible]	[illegible]	[illegible]	[illegible]	42	[illegible]	5 to 1		45	7' 5"	4' [illegible]	[illegible]	7' 4"	5' 6"	5' 8"	10' 6"	Mainbour	Maintenant
[illegible]	10	45	[illegible]	[illegible]	[illegible]	[illegible]	45	[illegible]	5 to 1		50	7' 1"	5' 6"	6' 4"	7' 8"	6' 0"	10' 6"	Mainmorte	Mainteniez
7	10	45	10.00	450	8	6	54	8	5 to 1		55	7' 1"	5' 3"	6' 4"	7' 8"	6' 3"	10' 8"	Mainote	Maintenous

Knowles Vertical Triplex Power Pump

Style "I," Type No. 2.



Belted Pump. Double-Acting Piston Pattern.

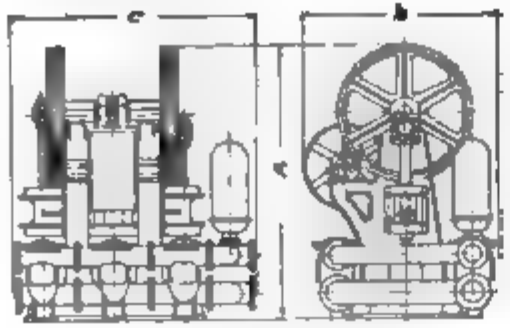
Size, 8 x 12.

Knowles Vertical Triplex Pumps Style "I," Type No. 2.

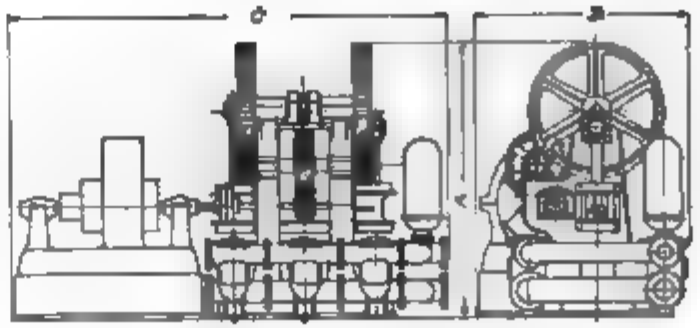
Double-Acting Piston Pattern.

THE construction of this pump differs somewhat from the plunger pattern, Styles A, F, and H, it having three double-acting pistons and the marine pattern connecting rod. The crank shaft is in one piece, working in babbitted bearings, supported between centre and outside cranks. The crossheads being guided, sustain the side thrust of the connecting rods. The power is transmitted direct to the pistons in the manner spoken of in description of Styles A and F. Connecting rods are steel, having babbitted boxes with adjustment on both ends. Each pump is furnished with a tight pulley and discharge air chamber, and has ample suction and discharge openings on either side. The removal of plates on top and side of valve chambers gives access to each set of suction and discharge valves. Upper pump cylinder heads, being made in halves, are easily removed, giving access to piston when adjustment is required. All gears are cut. The extended bed-plate, for the electric type is designed especially to receive the specified type and size of motor. A pinion of fibre will be furnished for the armature shaft, so as to reduce the noise to a minimum, if specially ordered, at extra price; otherwise a cast-iron cut pinion will be furnished. All material is of the highest grade, and great care is taken in the test to prove there is no defect. The sizes in the following table are suited for a pressure of 150 pounds.

In sending inquiries or orders, always state the water pressure.



Triplex Power Pumps (Belt Driven).
300 ft. Lift. Double-Acting Piston Pattern. Style "I," Type No. 2.



Triplex Electric Pumps (Geared).
300 ft. Lift. Double-Acting Piston Pattern. Style "I," Type No. 2.

Diameter of Pistons.	Stroke.	Revolutions per Minute.	Gallons per Revolution.	Gallons per Minute.	Suction	Discharge.	Pulley Diam.	Pulley Face.	Ratio of Pump Gears	Ratio of Motor Gears.	H. P. Motor Required.	Dimensions Over All. Belted Pumps Not Arranged for Motor A	B	C	Dimensions Over All. Arranged for Motor Geared A	B	C	Telegraphic Code Word. Belted Pumps Not Arranged for Motor.	Electric Pumps. Geared Arranged for Motor.
8½	12	40	12.00	480	8	6	30	16½	5 to 1	To Suit Speed of Motor	80	101	70	88	101	85	150	Fancied	Fance
8½	12	40	15.65	626	8	6	36	16½	4 72 to 1		95	101	70	89	101	88	155	Fanciful	Farcical
9	12	40	19.83	793	10	8	42	16½	5 to 1		80	101	74	89	101	92	162	Fancy	Farewell
10	12	40	24.48	979	12	10	48	18½	6 to 1		100	116½	84	98	116½	104	175	Fandango	Farina
11	12	40	29.62	1198	12	10	52	20½	6 to 1		120	124	86½	105	124	108	188	Fanged	Farmer
12	12	40	35.25	1410	14	12	56	22½	6 to 1		150	132	96	115	132	116	200	Fangless	Farming

Knowles Vertical Triplex Power Pump.

Style "K." Belted Pump. Double-Acting Piston Pattern.

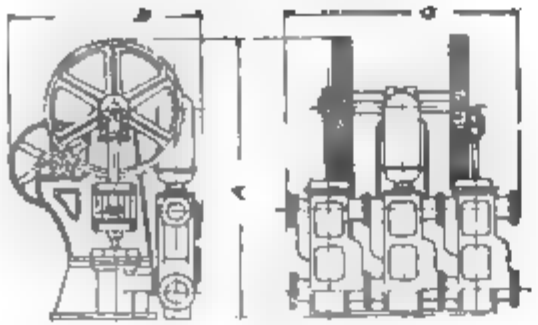
SIZE, 12 X 12

Pumps of smaller sizes have Valve Chests of different construction.

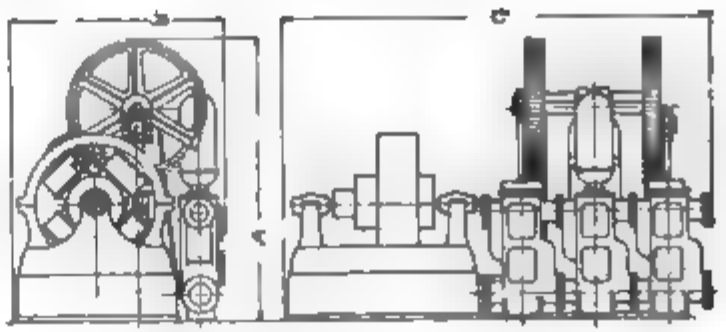
Double-Acting Piston Pattern.

This line of power pumps is designed for light service, where delivery of a large volume is required at a low pressure, and where floor space is restricted. The crank shaft is in one piece, working in adjustable babbitted bearings liberally proportioned. The power is transmitted direct to the pistons in the manner spoken of in description of Styles A and F. The connecting rods are steel, marine pattern, having adjustable babbitted boxes on both ends. There are ample suction and discharge openings on either side, and each pump is furnished with a tight pulley and discharge air chamber. Access to all valves is made easy by the removal of ample handhole plates on the valve chambers.

The adjustment of pistons is readily accomplished by the removal of the upper pump cylinder heads, which are made in halves for this purpose. All gears are cut. The extended bed-plate, for the electric type, is designed especially to receive the specified type and size of motor. For the armature shaft we will furnish a fibre pinion, to reduce the noise to a minimum, if specially ordered, at extra price, otherwise a cast-iron cut pinion will be furnished. The highest grade of material is used, and great care is taken in the test of pump to prove there is no defect. The following sizes are suitable for a pressure of 50 pounds. In sending inquiries or orders, always state the water pressure.



Triplex Power Pumps (Belt Driven
100 ft. Lift. Double-Acting Piston Pattern. Style "K."

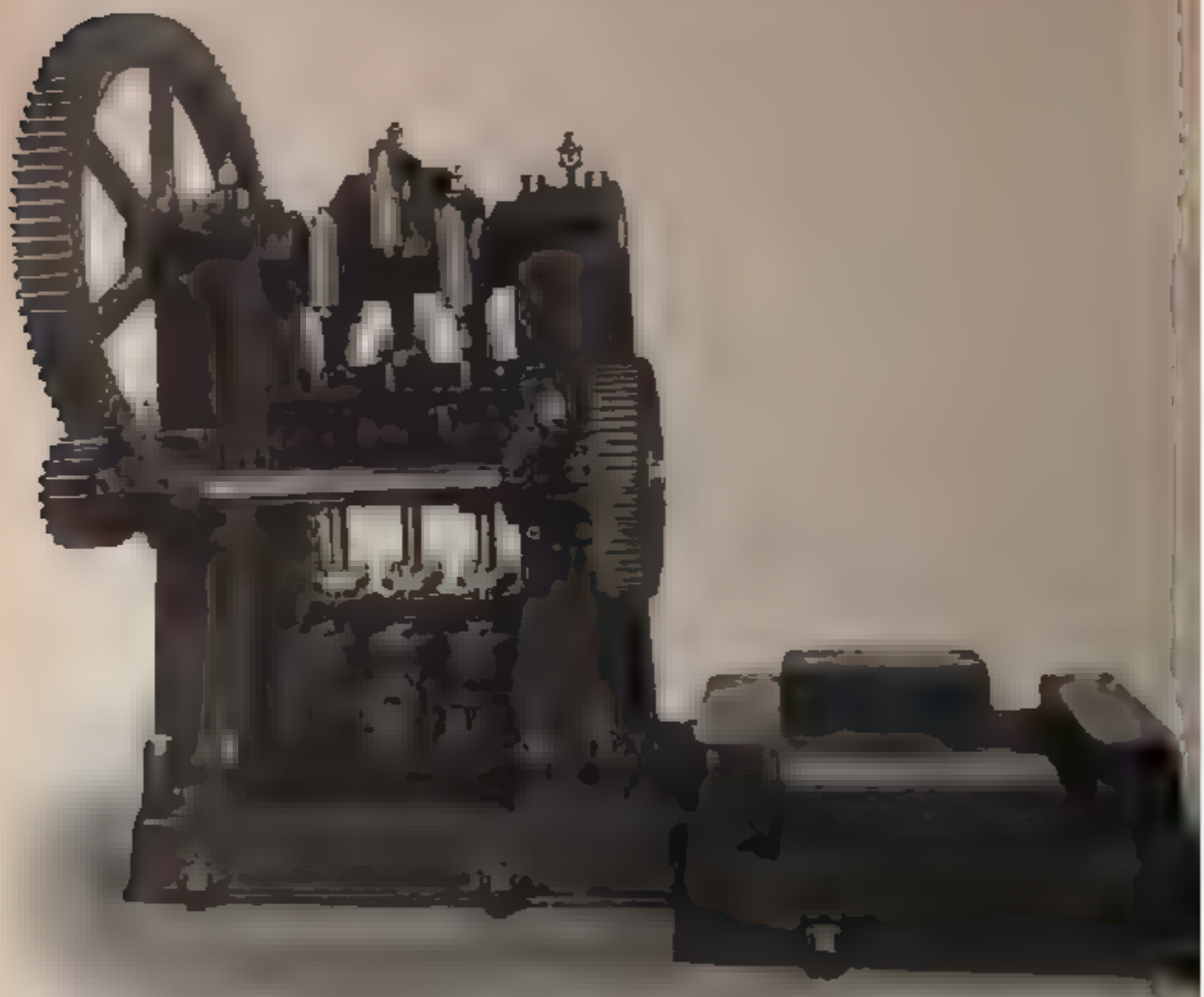


Triplex Electric Pumps (Geared).
100 ft. Lift. Double-Acting Piston Pattern. Style "K."

Diameter of Pistons.	Stroke.	Revolutions per Minute.	Gallons per Revolution	Gallons per Minute.	Suction	Discharge	Pulley Diam	Pulley Face	Ratio of Pump Gears	Ratio of Motor Gears	H. P. Motor Required	Dimensions Over All Belted Pumps Not Arranged for Motor. A	B	C	Dimensions Over All, Arranged for Motor, Geared. A	B	C	Telegraphic Code Word. Belted Pumps Not Arranged for Motor.	Electric Pumps, Geared. Arranged for Motor.
3	10	40	13.05	522	8	6	26	12½	5 to 1	To Suit Speed of Motor.	25	98	67	77	98	79	140	Maccum	Macellando
3½	10	40	16.52	661	8	6	26	12½	5 to 1		30	98	69	80	98	81	150	Maceaban	Macellassi
4	12	40	19.83	793	10	8	28	14½	5 to 1		35	91	70	80	101	88	155	Macendores	Macellava
4½	12	40	24.48	979	12	10	30	14½	5 to 1		40	116½	79	89	116½	90	168	Macendos	Macellinus
5	12	40	29.62	1185	12	10	30	14½	5 to 1		50	124	79	96	124	103	180	Maceare	Macellorum
5½	12	40	35.25	1410	14	12	30	16½	5 to 1		60	132	87	106	132	110	192	Maceasemos	Macerabat
6	12	40	41.34	1654	14	12	30	16½	5 to 1		70	140	90	115	140	115	205	Maceasteis	Macerador
7	12	40	47.94	1918	16	14	36	16½	5 to 1		80	148	98	125	148	130	220	Macebat	Macerun

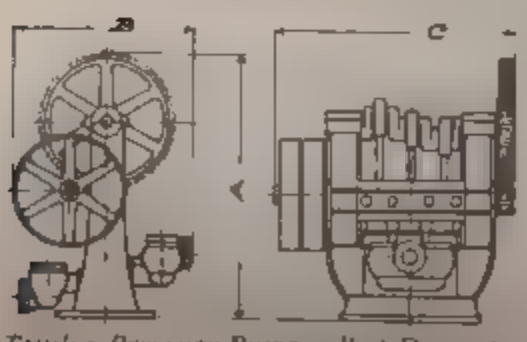
Knowles Vertical Triplex Pressure Pump.

Showing Extended Bed-plate for Motor.

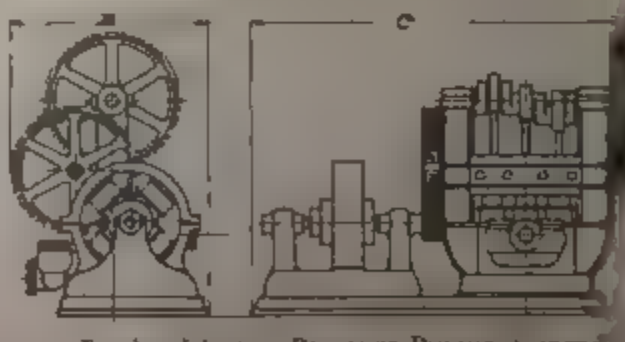


SIZE, 2 x 8.

When ordered belted, not arranged for motor, no sub-base is furnished.



Triplex Pressure Pumps (Belt Driven)



Triplex Electric Pressure Pumps (Geared)

Allowies Vertical Triplex Pressure Pumps.

THIS line of pumps is designed for hydraulic presses, cranes, filter presses, elevator service, for pipe lines and for other service where the pressure exceeds the ordinary 100 to 200 pounds per square inch. All sizes have ample suction and discharge openings. All gears are machine cut, thereby increasing smoothness of action and life of pump. The main frame is so constructed as to form guides for plungers, and being of exceptional strength and rigidity makes the pump self-contained and suited for the pressure stated in table. The plungers are single acting, and being guided perfect alignment is insured. They are driven by a powerfully geared three-throw crank shaft. The plungers are packed from the outside, so any leakage may be readily detected. Connecting rods are steel, having babbitted boxes on crank end with key adjustment, other end being solid with brass bushings.

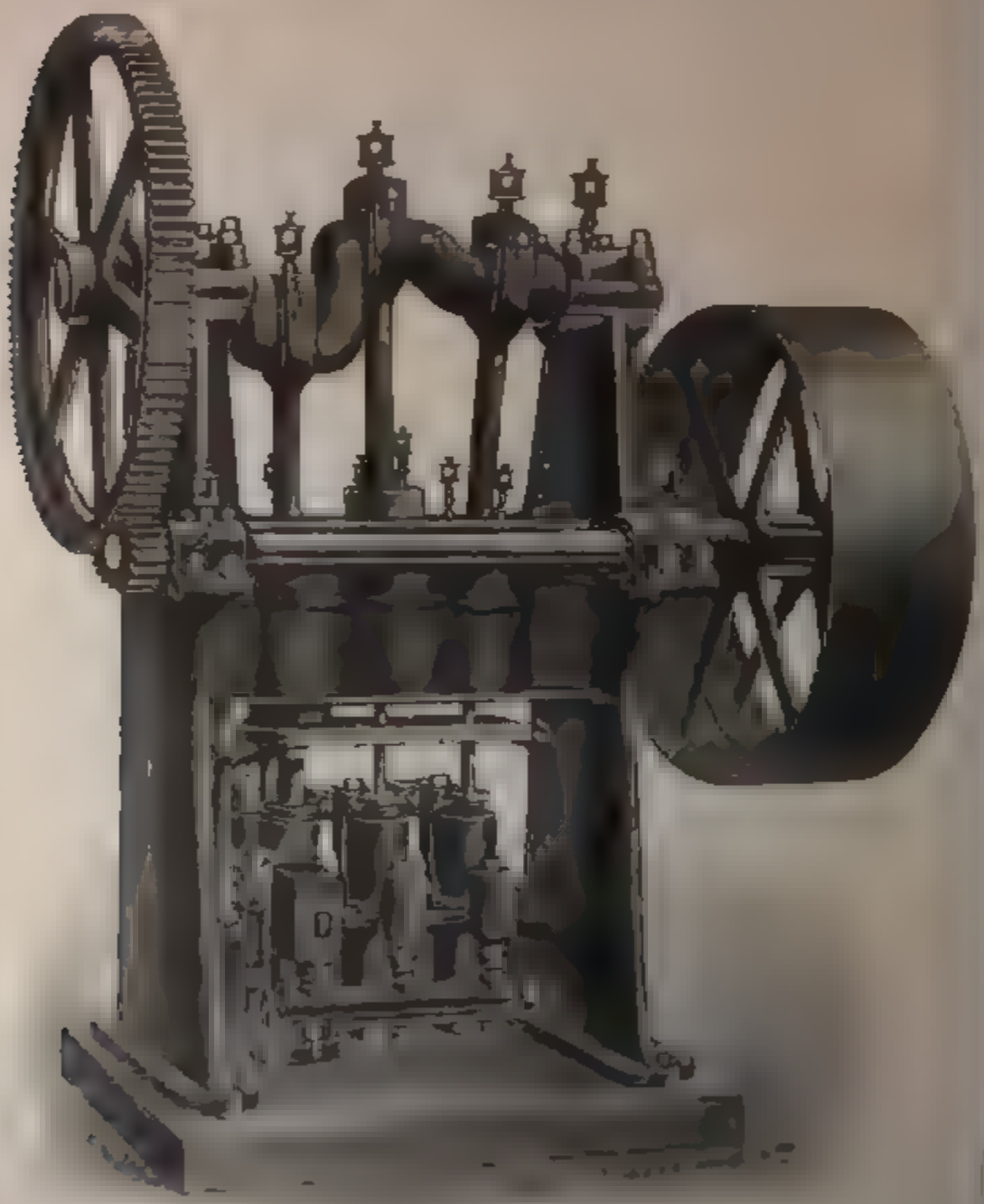
Each pump is furnished with tight and loose pulleys except those of 8" stroke, which have only one tight pulley. Access to all valves is made easy by the removal of plugs, or covers on valve chambers. Crank shaft and pulley shaft work in ample babbitted bearings. The extended bed-plate for the electric type, is designed especially to receive the specified type and size of motor. For the armature shaft we will furnish a fibre pinion, to reduce the noise to a minimum, if specially ordered, at extra price; otherwise a cast-iron cut pinion will be furnished.

All material is of the highest grade, and great care is taken in the test to prove there is no defect. The sizes in the following table are suited for pressures given in same. In sending inquiries or orders, always state as fully as possible the intended service and requirements.

Diameter of Plungers	Stroke	Maximum Pressure, Lbs	Revolutions Per Minute.	Gallons per Revolution.	Gallons per Minute.	Suction	Discharge.	Pulleys, Tight and Loose. Diam	Pulleys, Tight and Loose. Face	Ratio of Pump Gears	Ratio of Motor Gears	H P Motor Required.	Dimensions Over All Belted Pumps Not Arranged for Motor A	Dimensions Over All Belted Pumps Not Arranged for Motor B	Dimensions Over All Belted Pumps Not Arranged for Motor C	Dimensions Over All Arranged for Motor, Geared. A	Dimensions Over All Arranged for Motor, Geared. B	Dimensions Over All Arranged for Motor, Geared. C	Telegraphic Code Words. Belted Pumps Not Arranged for Motor	Telegraphic Code Words. Electric Pumps, Geared Arranged for Motor
¾	2	700	65	.0170	1.11	¾	½	12	1¼	5 to 1	To Suit Speed of Motor	1	19	13¾	15⅛	22	30	48	Maceris	Machilo
⅞	2	600	65	.0150	1 01	¾	¾	12	1¼	5 to 1		1	19	13¾	15⅛	22	30	48	Macesceres	Machinabor
1	3	1200	30	.0172	0 62	¾	½	15	3	5 to 1		1½	30½	19¾	20⅛	34⅜	31	53½	Macescet	Machinacac
1⅛	3	800	65	.0668	4 50	1¼	1¼	18	3½	5 to 1		2½	27	19⅜	24	31	32	53½	Macescunt	Machinales
2	3	400	30	.1224	3 67	1¼	1¼	15	3	5 to 1		1½	30½	19¾	20⅛	34⅜	31	53½	Macetarum	Machinamen
1	4	1100	40	.0976	3 61	1	1	15	3	5 to 1		2	40	28½	38	44	33	53½	Machabeos	Machinamur
1½	4	800	40	.0915	3 67	1¼	1¼	15	3	5 to 1		2	40	28½	38	44	33	53½	Machabeum	Machinando
2⅛	4	500	40	.2065	8 26	2	1½	20	4	5 to 1		5	40	30	40	44	34	60	Machacados	Machinasse
2⅞	4	350	40	.2301	9 20	2	1½	20	4	5 to 1		5	40	30	40	44	34	60	Machacaz	Machinatam
⅜	6	9000	40	.0153	.612	¼	½	20	4	5 to 1		5	51	35	42	59	35	65	Machacona	Machinator
½	6	4000	40	.0344	1.37	½	½	20	4	5 to 1		5	54	36	42	59	35	65	Machacones	Machineras
1	6	2250	40	.0612	2.45	1¼	1	20	4	5 to 1		5	54	36	42	59	35	65	Machadinha	Machineta
1½	6	1000	40	.1375	5 50	1¼	1¼	20	4	5 to 1		5	51	36	42	59	35	65	Machaereus	Machinho
2	6	675	40	.2445	9 70	2	1½	30	5	5 to 1		10	51	40	49	59	43	79	Machagent	Machiniser
2½	6	433	40	.5507	22 03	2	2	30	5	5 to 1		10	51	40	49	59	43	79	Machanaim	Machinoir
2½	6	400	40	.7497	29 98	2	2	30	5	5 to 1		10	51	40	49	59	43	79	Machane	Machinosos
2⅝	6	300	40	.9792	39 17	2	2	30	5	5 to 1		10	51	40	49	59	43	79	Machanidas	Machinosum
4⅜	6	800	35	1.239	55.75	3	3	42	6½	5 to 1		30	66	53	61	70½	45¼	69½	Machaon	Machinulis
								One Pulley.												
¾	8	20000	35	.0458	1 60	1	½	42	8½	5 to 1		25	77¼	62½	62	85¼	56½	102¼	Machaonem	Machione
⅞	8	15000	35	.0624	2 18	¾	1	42	8½	5 to 1		25	77¼	62½	62	85¼	56½	102¼	Machaonis	Machionis
1	8	12000	35	.0816	2 85	1¼	1	42	8½	5 to 1		25	77¼	62½	62	85¼	56½	102¼	Machaonium	Machionum
1⅛	8	8400	35	.1032	3 61	2	1½	42	8½	5 to 1		25	77¼	62½	62	85¼	56½	102¼	Machaques	Machlosyne
2	8	3000	35	.3263	11 42	2	1½	42	8½	5 to 1		25	77¼	62½	62	85¼	56½	102¼	Machary	Machlyes
2⅝	8	1900	35	.5090	17 81	3	2	42	8½	5 to 1		25	77¼	62½	62	85¼	56½	102¼	Machatins	Machmas
3	8	1500	35	.7343	25.70	3	2	42	8½	5 to 1		30	77¼	62½	62	85¼	56½	102¼	Machbanai	Macho

Knowles Vertical Triplex Pressure Pump.

Belted Pump. For Variable Delivery.

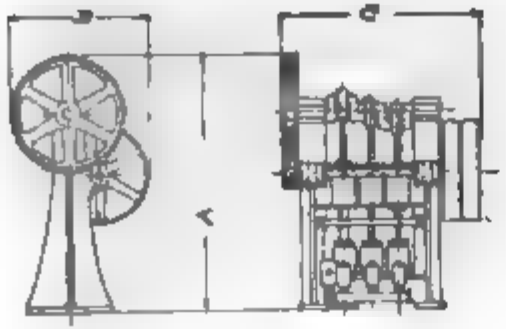


Size, 4 and 4½ x 6.

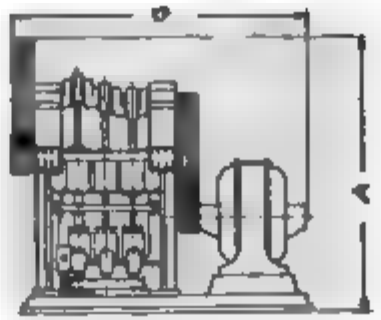
...lined delivery of the three plungers, until a specified pressure is reached, when an automatic device cuts out the larger plunger and the operation is continued by the smaller plungers to the desired pressure. The pressure on the larger plunger should not exceed 25 per cent. of the maximum pressure exerted by the pump.

All sizes have ample suction and discharge openings. All gears are machine cut, giving smoother action and longer life to pump. The construction is such that the pump is self-contained and of great strength. The plungers are single-acting, guided, insuring perfect alignment, and are packed from the outside, so that any leakage may readily be detected. Connecting rods are steel, ...removal of gauge or covers on valve chambers. Crank and ... shafts work in ample babbitted bearings. The extended bed-plate, for the electric type, is designed especially to receive the specified type and size of motor. We will furnish for the armature shaft a fibre pinion, to reduce the noise to a minimum, if specially ordered, at extra price; otherwise a cast-iron cut pinion will be furnished. The highest grade of materials are used, and great care is taken in the test of pump to prove there is no defect.

The sizes in the following table are suited for pressures given in same. Pressure pumps of this form are suitable for baling presses, testing machines, etc., in mills and factories. In sending inquiries or orders, always state as fully as possible the intended service and requirements.



Triplex Pressure Pumps (Belt Driven). For Variable Delivery.

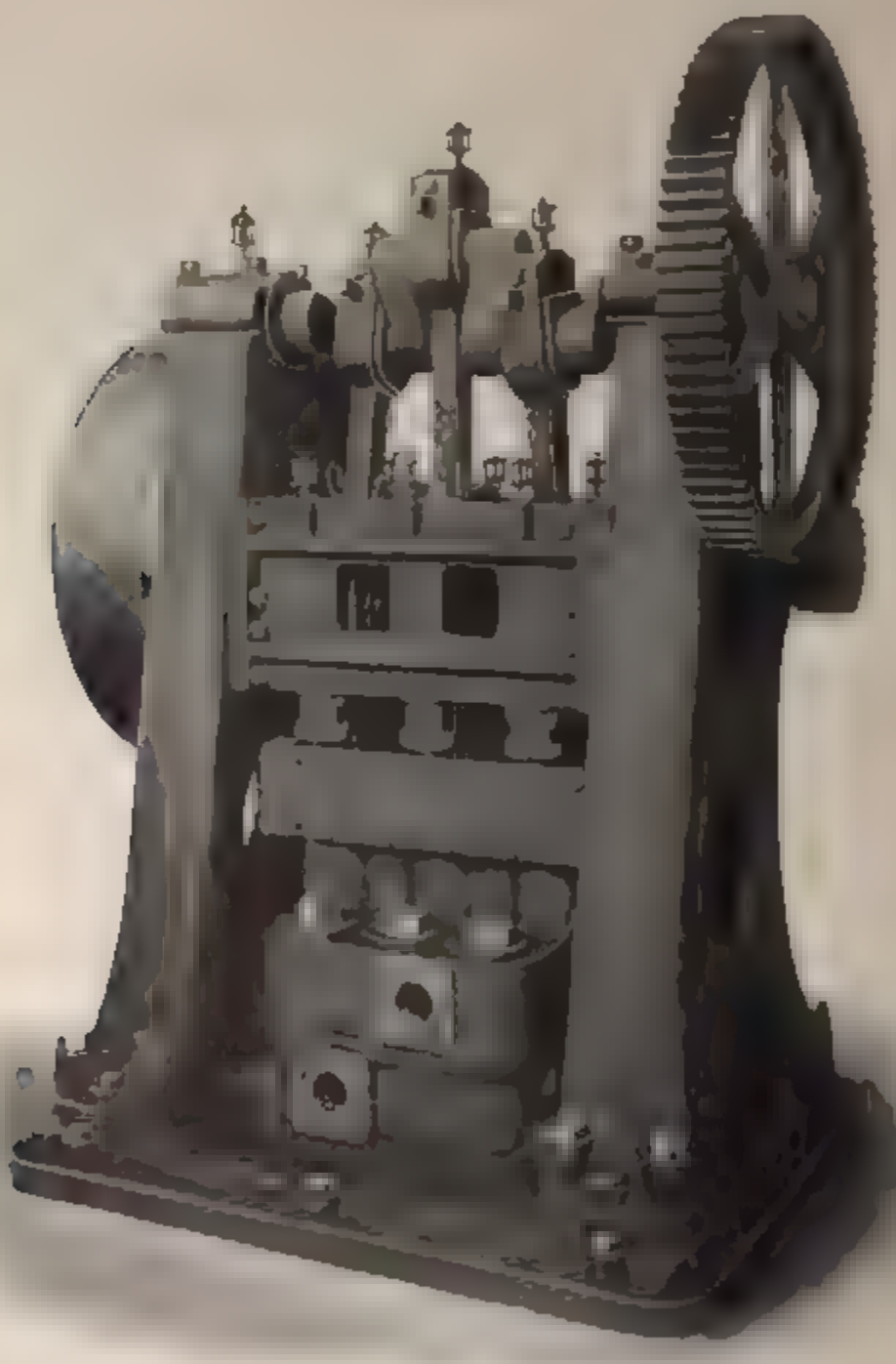


Triplex Electric Pressure Pumps (Geared). For Variable Delivery.

Plungers. Diameter.	Plungers. Stroke.	Maximum Pressure, Lbs.	Revolutions per Minute	Gallons per Revolution	Gallons per Minute.	Suction.	Discharge.	Pulleys, Tight and Loose. Diam	Pulleys, Tight and Loose. Face.	Ratio of Pump Gears	Ratio of Motor Gears.	H. P. Motor Required	Dimensions Over All Belted Pumps Not Arranged for Motor. A	B	C	Dimensions Over All. Arranged for Motor. Geared. A	B	C	Telegraphic Code Word. Belted Pumps Not Arranged for Motor.	Telegraphic Code Word. Electric Pumps. Geared. Arranged for Motor.
¾	1½	6000	40	.0688	2.751		¼	20	4	5 to 1	To Suit Speed of Motor	5	58	30	48	63	35	70	Machron	Machtwort
1	2	3000	40	.1224	4.896	1¼	1	20	4	5 to 1		5	58	36	48	63	35	70	Machtgebot	Machucado
1½	3	1000	40	.2754	11.01	2	1½	20	4	5 to 1		5	58	36	48	63	35	70	Machtgever	Machucamos
								One Pulley												
¾	1½	5000	35	.0917	3.21	1¼	1	42	8½	5 to 1		25	83	62½	68	88	57	108	Machtiging	Machucar
1	2	4500	35	.1632	5.71	1½	1¼	42	8½	5 to 1		25	83	62½	68	88	57	108	Machtloser	Machucaron
1½	3	4000	35	.3672	12.85	2	1½	42	8½	5 to 1		25	83	62½	68	88	57	108	Machtquell	Machucanos

Knowles Vertical Triplex Ammonia Pump.

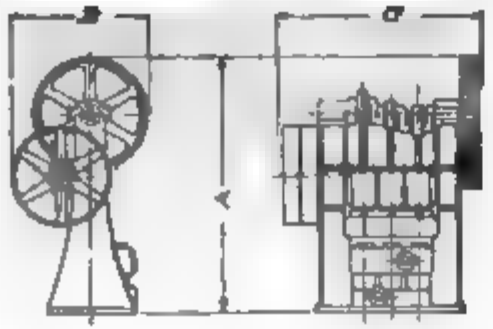
Belted.



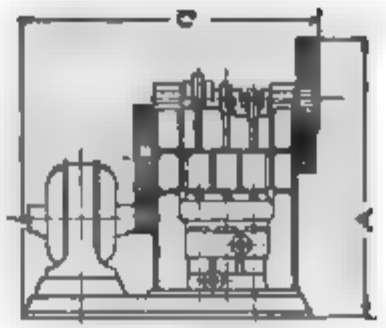
Size, 5 x 8

For Maximum Pressure of 250 Pounds.

THIS style of pump is constructed for pumping aqua ammonia for cold storage and ice-making plants, etc. It works uniformly at all times without constant adjustment or attention, thereby increasing the refrigerating capacity of the plant. As a result of its steady work, leakage of the many coils and joints of the piping is a minor consideration in comparison with that of other makes. It is a substantial and well-built pump, requiring but small floor space. The three single-acting plungers are fitted with water seal. Among the advantages possessed by this pump may be cited the ample suction and discharge openings, machine cut gears, steel connecting rods with babbitted box on crank end and brass bushing on crosshead end, large babbitted bearings for pulley and crank shafts, the latter shaft being made in one piece. The extended bed-plate, for the electric type, is designed especially to receive the specified type and size of motor. All wearing parts are arranged for taking up when worn. Belted pumps furnished with tight and loose pulleys. To reduce the noise to a minimum, we will furnish a fibre pinion for the armature shaft, at extra price, but unless so specified a cast-iron cut pinion will be furnished. Materials of the highest grade are used in construction and great care is taken in the test of pump to prove there is no defect. Sizes in table are suited for a maximum pressure of 250 pounds. In sending inquiries or orders, state fully the services required of the pump.



Triplex Ammonia Pumps (Belt Driven)
For Maximum Pressure of 250 Pounds.

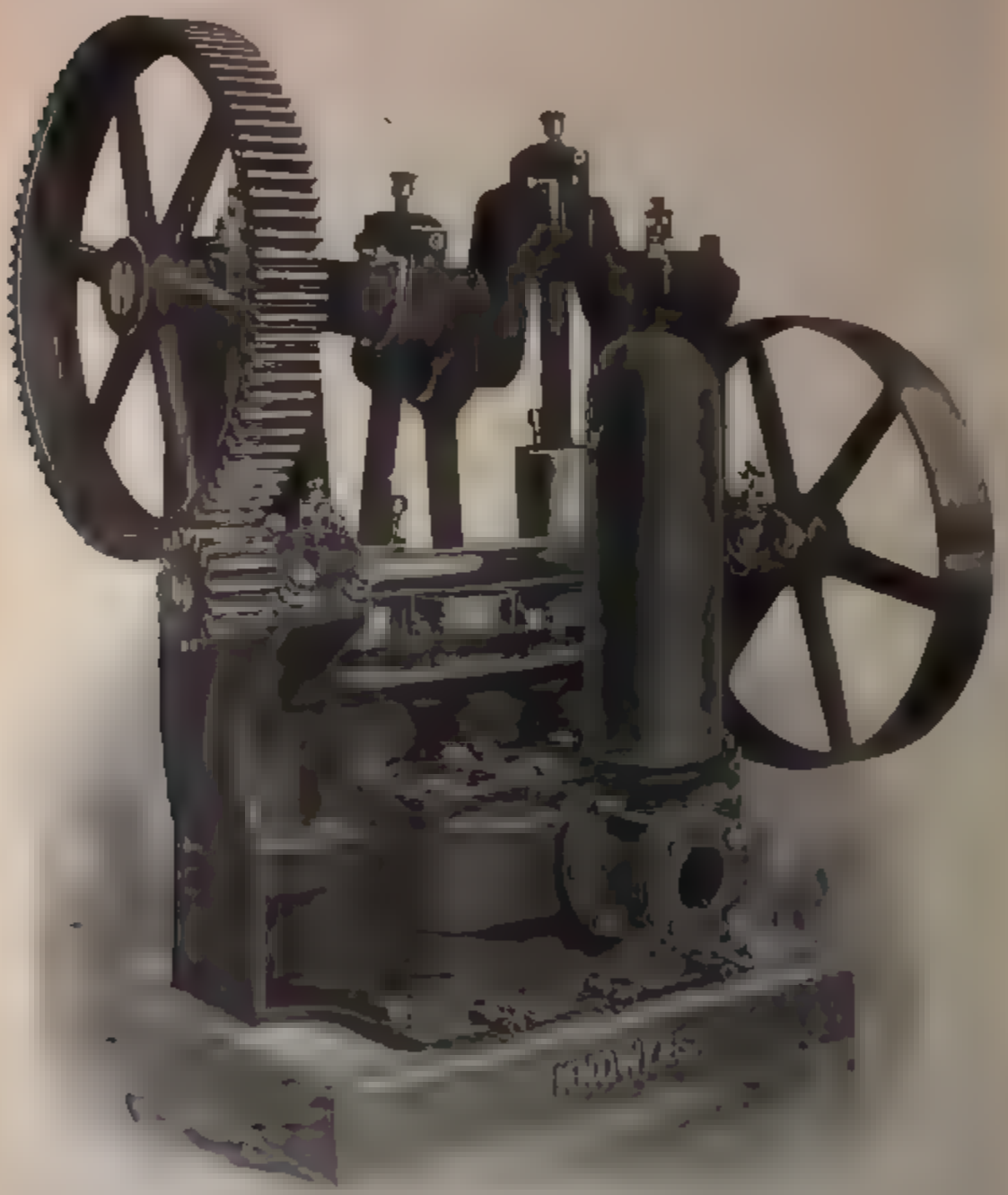


Triplex Electric Ammonia Pumps (Geared).
For Maximum Pressure of 250 Pounds.

Diameter of Plungers.	Stroke.	Revolutions per Minute	Gallons per Revolution	Gallons per Minute	Suction	Discharge	Pulleys, Tight and Loose: Diam	Pulleys, Tight and Loose: Face	Ratio of Pump Gears	Ratio of Motor Gears.	H. P. Motor Required.	Dimensions Over All Belted Pumps Not Arranged for Motor: A	B	C	Dimensions Over All, Arranged for Motor, Geared: A	B	C	Telegraphic Code Word. Belted Pumps Not Arranged for Motor.	Electric Pumps, Geared, Arranged for Motor.
2¼	3	40	.0477	1.908	1¼	1¼	12	1¾	5 to 1	To Suit Speed of Motor	¾	36	20	32	40	24	56	Maciabit	Macini
2½	3	40	.1224	4.896	1¼	1¼	15	3	5 to 1		1½	40	26	35	44	30	59	Maciabitis	Macinini
2¾	6	40	.2151	8.606	2	1½	15	3	5 to 1		2	58	32½	40	63	39	64	Maciaret	Macinoso
3	6	40	.2448	9.792	2	1½	18	3	5 to 1		2½	58	34	40	63	36	64	Maciaretis	Macisbohne
3½	6	40	.3825	15.300	2	2	20	4	5 to 1		4½	59	35	47	64	38	69	Maciidez	Maciullano
4	6	40	.5568	22.032	2	2	20	4	5 to 1		5	60	35	47	65	38	75	Macieira	Maciullare
4½	6	40	.9792	39.168	2	2	30	5	5 to 1		10	62	40	49	67	43	80	Maclemus	Maciullava
5	6	40	1.530	61.200	3	3	30	5	5 to 1		16	64	40	62	69	55	97	Macilence	Macizar
5½	8	40	.9936	39.984	2	2	30	5	5 to 1		10	71	40	62	76	48	105	Macinamus	Macizaron
6	8	40	1.305	52.224	3	3	30	5	5 to 1		12½	71	40	62	76	48	105	Macinandos	Mackles
7	8	40	2.040	81.600	3	3	36	6	5 to 1		20	74	45	64	79	58	110	Macinandum	Macline

Knowles Vertical Triplex Brine Pump.

Belted Pump.



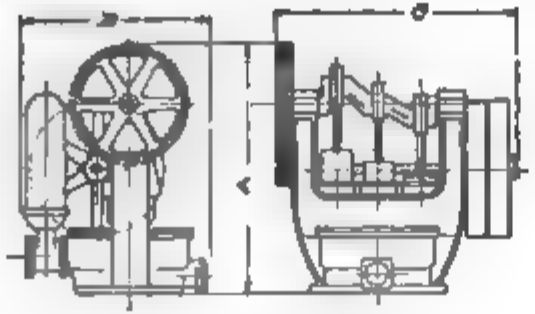
SIZE, 8 x 8.

(Smaller sizes have cylinders and frame cast in one piece.)

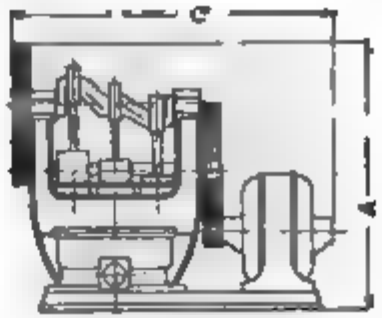
Knowles Vertical Triplex Brine Pumps.

For 100 Feet Lift.

THIS style of triplex pumps is designed to circulate brine in refrigerating and cold-storage plants, etc. It is a substantial and well-built pump, of neat and compact design and requires but small floor space. When fitted for pumping solutions of chloride of calcium for refrigerating purposes, it has iron plungers, cylinders, glands, and rubber disk valves. These parts will be made of bronze, at extra price, if specially ordered, when the pump is to circulate solutions of common salt or other fluids destructive to iron. Belted pumps are furnished with tight and loose pulleys. Each pump has a discharge air chamber and has the suction and discharge openings located on opposite sides. This pump, in common with Style E, has the following advantages. Three single-acting outside packed plungers, ample suction and discharge openings, machine-cut gears, steel connecting rods with babbitted box on crank end and brass bushing in lower end, held in plunger by steel pin, large babbitted bearings for pulley and crank shafts, the latter shaft being made in one piece and the base, for the electric type, is specially designed to suit the specified size and type of motor. All wearing parts are arranged for taking up when worn. See note in description of Style E in regard to fibre pinion and grade of material used. In sending inquiries or orders, state fully the service required of the pump.



Triplex Brine Pumps (Belt Driven) 100 ft. Lift.

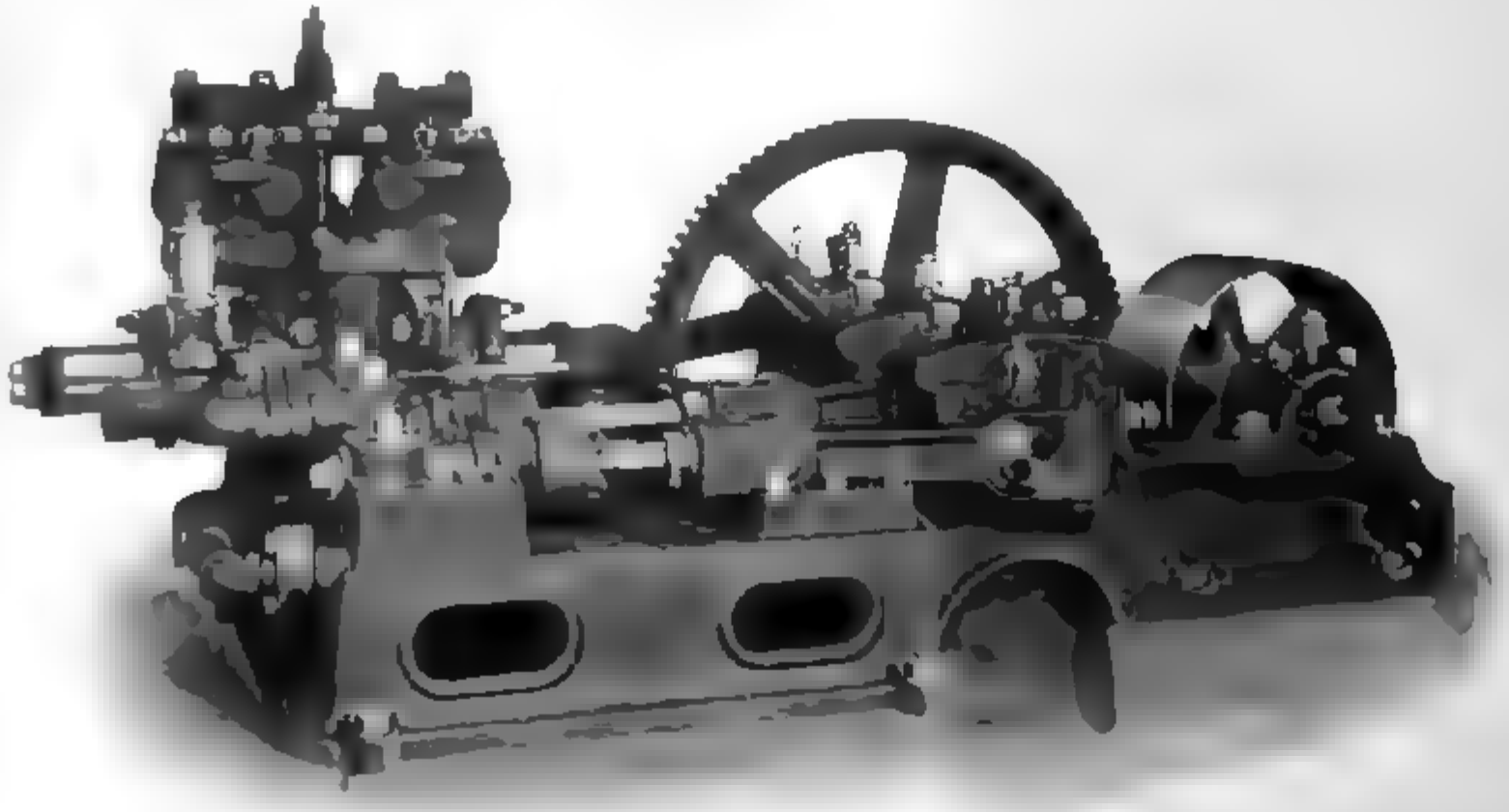


Triplex Electric Brine Pumps (Geared) 100 ft. Lift.

Diameter of Plungers.	Stroke	Revolutions per Minute	Gallons per Revolution	Gallons per Minute	Suction	Discharge	Pulleys, Tight and Loose. Diam	Pulleys, Tight and Loose. Face	Ratio of Pump Gears.	Ratio of Motor Gears.	H. P. Motor Required	Dimensions Over All Belted Pumps Not Arranged for Motor. A	B	C	Dimensions Over All Arranged for Motor, Geared. A	B	C	Telegraphic Code Word: Belted Pumps Not Arranged for Motor.	Telegraphic Code Word: Electric Pumps Geared Arranged for Motor.
4	4	45	.6528	29.37	2	2	20	3	5 to 1	To Suit Speed of Motor	1½	38¼	28½	34⅞	42½	29	51	Macoris	Macritus
4	6	40	.0757	30.15	2	2	20	3	4 to 1		2	38¼	28½	34⅞	42½	29	52	Macotonic	Macrobe
5	6	40	1.530	61.20	3	3	20	4	4 to 1		3	45¼	34½	43½	49½	41	61¼	Macoucou	Macro[illegible]
5	8	40	2.040	81.60	3	3	20	4	4 to 1		4	45¼	34½	43½	49½	41	67	Macquage	Macr[illegible]
6½	8	40	3.448	137.92	4	4	26	5	4 to 1		7	49¼	39¼	51¼	54¼	45	74	Macquerie	Macr[illegible]
7	8	40	3.998	159.92	5	4	30	5	4½ to 1		8	55	43	54	60	47	80	Macquevin	Macro[illegible]
8	8	40	5.222	208.88	5	4	30	6	5 to 1		10	56	48	59	62½	48	85	Macquoir	Macro[illegible]
8	10	40	6.525	261.00	5	4	36	6	5 to 1		12½	55¾	48	68	65	48	94	Macra	Macro[illegible]
8	12	40	7.833	313.32	5	4	36	6	6 to 1		15	69	48	68	74	48	96	Macranthe	Macro[illegible]
9	10	40	8.262	330.48	6	5	36	6	6 to 1		17	69	50	71	74	50	100	Macranto	Macro[illegible]
9	12	40	9.912	396.48	6	5	42	8	6 to 1		20	80	50	75	85	53	106	Macraspide	Macrod[illegible]
10	12	40	12.240	489.60	8	7	42	8	6 to 1		25	84	52	80	89	53	115	Macrescet	Macrog[illegible]

Knowles Horizontal Triplex Pressure Pump.

Belted Pump. For Variable Delivery (as listed in lower part of table, page 43).



Size, 2¼ and 5 x 6.

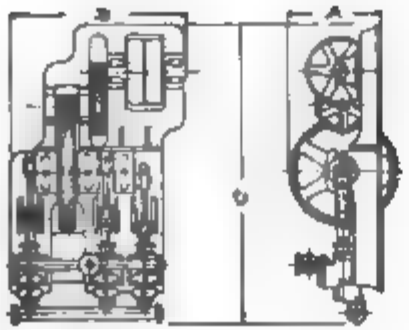
For description and list of sizes, see pages 41 and 43.

up requires less head-room than the vertical triplex. The plungers are
ng and have outside stuffing-boxes which can be readily packed, and
ght, any leakage of water through the glands can be quickly detected.
gnment is assured by the crossheads, the large bearing surface of which
lieves the wear on packing and glands. The valve chambers, cylinders,
parts exposed to pressure, are made separate as far as possible, in order
e renewals or repairs, should occasion arise through accident or negli-
he water valves are arranged in a series of chambers containing one or
es, access to which is made easy by the removal of covers. In common
ertical pressure pumps, this style of pump has ample suction and dis-
enings, machine-cut gears, steel connecting rods, ample babbitted bear-
ank and pulley shafts, and the base, for the electric type, is specially
to suit the specified size and type of motor. All wearing parts are
or taking up when worn. For the armature shaft we will furnish a fibre
reduce the noise to a minimum, if specially ordered, at extra price;
a cast-iron cut pinion will be furnished. The highest grade of material
d great care is taken in the test of pump to prove there is no defect.
given are suited for pressures stated in tables.

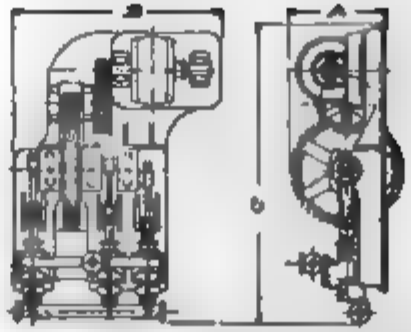
tyle of pump in lower table is shown by cut on opposite page and differs
n that in upper table. Instead of having three cylinders the same
er is larger in diameter and double-acting, thus giving greater
the others. When used with a press or other hydraulic

Knowles Horizontal Triplex Pressure Pumps.

For Illustration and Description see Pages 40 and 41.
For List of Sizes see opposite page.



Horizontal Triplex Pressure Pumps.
(Belt Driven.)



Horizontal Triplex Electric Pressure Pumps.
(Geared.)

Knowles Horizontal Triplex ...

For Illustration and Description see Pages 40 and 41. For Outline Cuts see opposite page.

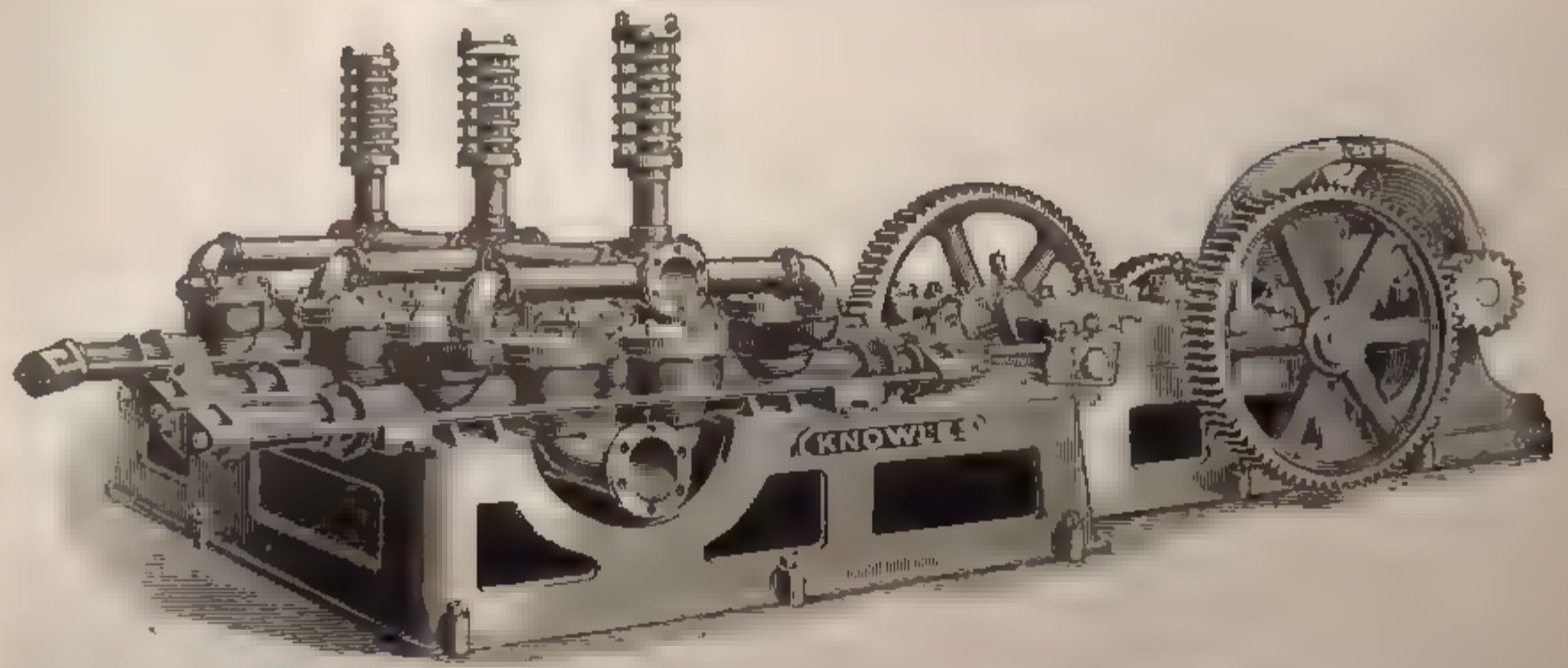
Diameter of Plunger.	Stroke.	Maximum Pressure, Lbs.	Revolutions per Minute.	Gallons per Revolution.	Gallons per Minute.	Suction.	Discharge.	Pulleys, Tight and Loose — Diam.	Pulleys, Tight and Loose — Face	Ratio of Pump Gears.	Ratio of Motor Gears	H. P. Motor Required	Dimensions Over All, Belted Pumps Not Arranged for Motor — A	B	C	Dimensions Over All, Arranged for Motor Geared — A	B	C	Telegraphic Code Word. Belted Pumps Not Arranged for Motor.	Electric Pumps, Geared, Arranged for Motor.
⅜	6	9000	40	.0153	.612	¾	¾	20	4	5 to 1	To Suit Speed of Motor	5	2′ 8″	5′ 0″	8′ 6″	3′ 2″	5′ 10″	9′ 0″	Maestral	Magazijn
½	6	4000	40	.0344	1.37	1	¾	20	4	5 to 1		5	2′ 8″	5′ 0″	8′ 6″	3′ 2″	5′ 10″	9′ 0″	Maestrammo	Magazinlog
⅝	6	2250	40	.0612	2.45	1½	1	20	4	5 to 1		5	2′ 8″	5′ 0″	8′ 6″	3′ 2″	5′ 10″	9′ 0″	Maestrando	Magazinist
1	6	1000	40	.1376	5.50	1½	1¼	20	4	5 to 1		5	2′ 8″	5′ 0″	8′ 6″	3′ 2″	5′ 10″	9′ 0″	Maestrassi	Magbish
2	6	975	40	.2448	9.79	2	1½	30	5	5 to 1		10	3′ 0″	5′ 5″	9′ 0″	3′ 6″	6′ 6″	9′ 7″	Maestrava	Magdalena
3	6	433	40	.5507	22.03	2	2	30	5	5 to 1		10	3′ 0″	5′ 5″	9′ 0″	3′ 6″	6′ 6″	9′ 7″	Maestrerai	Magdaliao
3½	6	400	40	.7497	29.99	2	2	30	5	5 to 1		10	3′ 0″	5′ 5″	9′ 0″	3′ 6″	6′ 6″	9′ 7″	Maestriles	Magdalidum
4	6	300	40	.9792	39.17	2	2	30	5	5 to 1		10	3′ 0″	5′ 5″	9′ 0″	3′ 6″	6′ 6″	9′ 7″	Maestrino	Magdlobnes
4½	6	600	45	1.239	55.75	3	3	42	6½	5 to 1		30	4′ 3″	6′ 6″	10′ 4″	4′ 6″	7′ 4″	11′ 1″	Maestrone	Magdolum
								One Pulley.												
⅜	8	20000	35	.0158	1.66	1	¾	42	8½	5 to 1		25	3′ 7″	5′ 6″	9′ 6″	4′ 0″	7′ 0″	11′ 6″	Maestruzza	Magen
⅝	8	15000	35	.0624	2.18	1¼	1	42	8½	5 to 1		25	3′ 7″	5′ 6″	9′ 6″	4′ 0″	7′ 0″	11′ 6″	Maestung	Magenader
1	8	12000	35	.0816	2.86	1¼	1	42	8½	5 to 1		25	3′ 7″	5′ 6″	9′ 6″	4′ 0″	7′ 0″	11′ 6″	Maesulorum	Magenball
1½	8	5400	35	.1832	6.41	2	1½	42	8½	5 to 1		25	3′ 11″	6′ 0″	10′ 8″	4′ 3″	7′ 2″	12′ 0″	Maesulos	Magenbrea
2	8	3000	35	.3263	11.42	2	1½	42	8½	5 to 1		25	3′ 11″	6′ 0″	10′ 8″	4′ 3″	7′ 2″	12′ 0″	Maetona	Magenbruch
2½	8	1900	35	.5098	17.84	3	2	42	8½	5 to 1		25	3′ 11″	6′ 0″	10′ 8″	4′ 3″	7′ 2″	12′ 0″	Maetichen	Magenfell
3	8	1500	35	.7343	25.70	3	2	42	8½	5 to 1		30	4′ 3″	6′ 6″	11′ 2″	4′ 6″	7′ 4″	12′ 6″	Maetzlein	Magengrube

Horizontal Triplex Pressure Pumps (for Variable Delivery) Like Cut on Page 40.

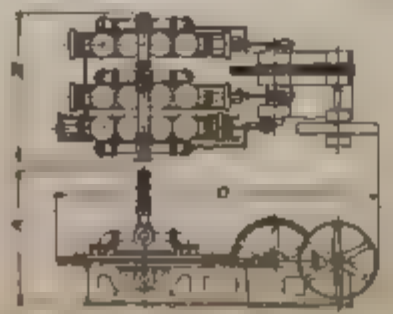
								Tight and Loose — Diam.	Tight and Loose — Face	Ratio of Pump Gears.	Ratio of Motor Gears	H. P. Motor Required								
⅜ & 1½	6	4000	40	.0686	2.75	1	¾	20	4	5 to 1	To Suit Speed of Motor	5	3′ 3″	5′ 6″	8′ 6″	3′ 10″	7′ 0″	10′ 6″	Maevius	Magenreiz
½ & 2	6	2250	40	.1224	4.89	1½	1	20	4	5 to 1		5	3′ 3″	5′ 6″	8′ 6″	3′ 10″	7′ 0″	10′ 6″	Malametico	Magenruhr
⅝ & 3	6	1000	40	.2754	11.01	2	1½	20	4	5 to 1		5	3′ 3″	5′ 6″	8′ 6″	3′ 10″	7′ 0″	10′ 6″	Mafoma	Magenstein
								One Pulley.												
¾ & 5	6	1000	40	.7165	28.66	4	3	20	10½	5 to 1		10	3′ 7″	5′ 11″	8′ 11″	4′ 2″	7′ 6″	11′ 0″	Maforte	Magenstich
⅝ & 1½	8	20000	35	.0917	3.21	1½	1	42	8½	5 to 1		25	4′ 6″	5′ 7″	9′ 6″	5′ 0″	7′ 1″	12′ 0″	Mafrach	Magenwurm
& 2	8	13000	35	.1632	5.71	1½	1¾	42	8½	5 to 1		25	4′ 6″	5′ 7″	9′ 6″	5′ 0″	7′ 1″	12′ 0″	Magabeira	Magerder
1½ & 3	8	5400	35	.3672	12.84	2	1½	42	8½	5 to 1		25	4′ 6″	5′ 7″	9′ 6″	5′ 0″	7′ 1″	12′ 0″	Magadhi	Magericao

Knowles Horizontal Triplex Outside Plunger Pump.

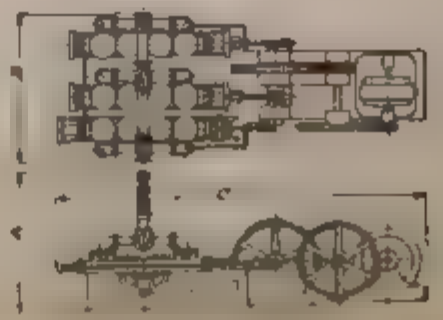
Electric Pump (Geared). Double-Acting.



Size, 7½ x 12



Horizontal Triplex Outside Plunger Pumps
Double Acting (Belt Driven).



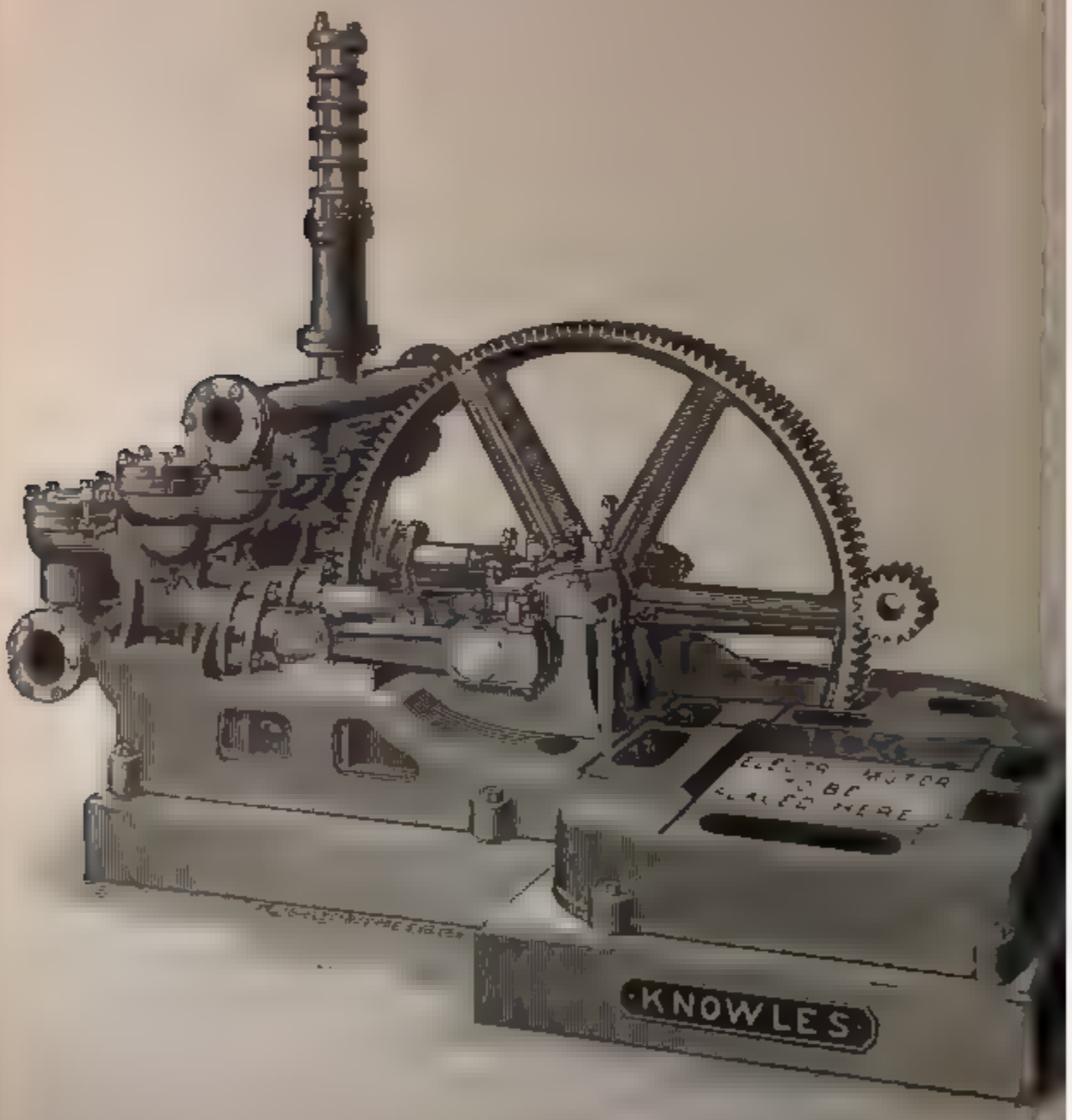
Horizontal Triplex [illegible] Outside Plunger Pump
Double Acting (Geared)

[illegible] changes in proportions to meet the requirements of any special service. Our experience in this line has enabled us to embody in this pump all the essentials which insure durability, reliability, convenience, and compactness. Electric pumps are arranged ready to receive motor placed at one end of a girder-type bed-plate, the power being transmitted to the crank shaft by heavy double-reduction gearing. Belt-driven pumps have single-reduction gearing. All gears are cut, thus increasing smoothness of action and life of pump. Suction and discharge openings on either side. For belted pumps one tight pulley is furnished for sizes up to and including 10 x 12. The plungers are driven by steel connecting rods having babbitted boxes with key adjustment on plungers or "alleviators" for equalizing the water flow. [illegible] wearing parts are arranged for taking up when worn. For the armature shaft we will furnish a fibre pinion, to reduce the noise to a minimum, if specially ordered, at extra price; otherwise a cast-iron cut pinion will be furnished. The highest grade of material is used and great care is taken in the test of pump to prove there is no defect. The electrically-driven type is especially recommended for heavy lifts in general mining work, where the use of steam pipe is objectionable on account of limited space or liability to mechanical injury and consequent leakage. In sending inquiries or orders, always state as fully as possible the intended service and requirements.

Diameter of Plungers.	Stroke.	Maximum Lift in Feet.	Revolutions per Minute.	Gallons per Revolution.	Gallons per Minute.	Suction.	Discharge.	Pulley. Diam.	Pulley. Face.	Ratio of Pump Gears.	Ratio of Motor Gears.	H. P. Motor Required.	Dimensions Over All. Belted Pumps Not Arranged for Motor. A	B	C	Dimensions Over All. Arranged for Motor. Geared. A	B	C	Telegraphic Code Word. Belted Pumps Not Arranged for Motor.	Telegraphic Code Word. Electric Pumps. Geared. Arranged for Motor.
5	12	630	50	6.12	306	6	5	60	13	4 to 1	To Suit Speed of Motor.	75	9' 0"	10' 3"	22' 0"	9' 0"	9' 3"	25' 6"	Magloire	Dragon
5½	12	520	50	7.40	370	6	5	60	13	4 to 1		75	9' 0"	10' 2"	22' 0"	9' 0"	9' 3"	25' 6"	Maglorio	Drama
6	12	430	50	8.81	441	8	6	60	13	4 to 1		75	9' 0"	10' 4"	22' 0"	9' 0"	9' 5"	25' 6"	Magmatis	Dreamy
6½	12	370	50	10.77	539	8	6	60	13	4 to 1		75	9' 0"	10' 4"	22' 0"	9' 0"	9' 5"	25' 6"	Magmatum	Dribbet
7	12	320	50	12.00	600	10	8	70	13	4 to 1		75	9' 0"	10' 8"	22' 0"	9' 0"	9' 9"	25' 6"	Magmentati	Drifting
7½	12	300	50	12.86	643	10	8	60	13	4 to 1		75	9' 0"	10' 8"	22' 0"	9' 0"	9' 9"	25' 6"	Magnaevi	Drivel
7½	12	280	50	13.77	689	10	8	60	13	4 to 1		75	9' 0"	10' 8"	22' 0"	9' 0"	9' 9"	25' 6"	Magnaevos	Drinking
8	12	240	50	15.66	783	10	8	60	13	4 to 1		75	9' 4"	10' 10"	22' 0"	9' 4"	9' 11"	25' 6"	Magnaevum	Drizzle
6	12	740	50	8.81	441	8	6	96	13	4 to 1		125	9' 0"	10' 4"	24' 0"	9' 0"	9' 5"	27' 0"	Magnality	Driveller
6½	12	600	50	10.77	539	8	6	96	13	4 to 1		125	9' 0"	10' 4"	24' 0"	9' 0"	9' 5"	27' 0"	Magnamente	Drivelling
7	12	540	50	12.00	600	10	8	96	13	4 to 1		125	9' 0"	10' 8"	24' 0"	9' 0"	9' 9"	27' 0"	Magnanage	Driven
7½	12	470	50	13.77	689	10	8	96	13	4 to 1		125	9' 0"	10' 8"	24' 0"	9' 0"	9' 9"	27' 0"	Magnanemas	Drivening
8	12	415	50	15.66	783	10	8	96	13	4 to 1		125	9' 4"	10' 10"	24' 0"	9' 4"	9' 11"	27' 0"	Magnantano	Driver
9	12	332	50	19.83	992	12	10	96	13	4 to 1		125	9' 4"	11' 0"	24' 0"	9' 4"	10' 2"	27' 0"	Magnarios	Driving
7	12	600	50	12.00	600	10	8	114	13	4 to 1		150	9' 0"	10' 8"	25' 0"	9' 0"	9' 9"	28' 0"	Magnarium	Dropsy
7½	12	530	50	13.77	689	10	8	114	13	4 to 1		150	9' 0"	10' 8"	25' 0"	9' 0"	9' 9"	28' 0"	Magnaten	Drizzling
8	12	460	50	15.66	783	10	8	114	13	4 to 1		150	9' 4"	10' 10"	25' 0"	9' 4"	9' 11"	28' 0"	Magnatibus	Drudge
9	12	360	50	19.83	992	12	10	114	13	4 to 1		150	9' 4"	11' 0"	25' 0"	9' 4"	10' 2"	28' 0"	Magnatorum	Drugget
10	12	300	50	24.45	224	12	10	114	13	4 to 1		150	9' 0"	11' 3"	25' 0"	9' 6"	10' 5"	28' 0"	Magnaudier	Drummer
10	12	600	50	24.45	1224	12	10			4 to 1		300				9' 6"	10' 5"	29' 0"		Drunkard
11	12	500	50	29.61	1481	14	12			4 to 1		300				9' 8"	10' 8"	29' 0"		Drunken
12	12	420	50	35.25	1763	14	12			4 to 1		300				9' 10"	11' 0"	29' 0"		Druxey
10	18	500	45	36.72	1469	14	12			4 to 1		300				9' 6"	10' 5"	30' 0"		Droll
11	18	480	40	44.43	1777	14	12			4 to 1		300				9' 8"	10' 8"	30' 0"		Drone
12	18	340	40	52.87	2115	16	14			4 to 1		300				9' 10"	11' 0"	30' 0"		Drench

Knowles
Horizontal Triplex Outside Plunger Pum

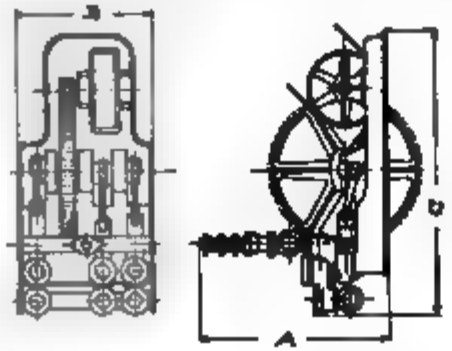
Electric Pump (Geared). Single-Acting.



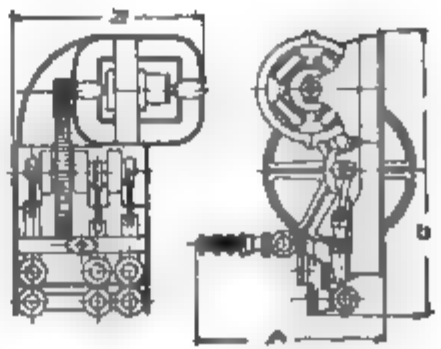
Size, 6½ x 8

Single-Acting.

THE cut on the opposite page shows our improved horizontal triplex pump, with single-acting plungers, fitted ready to receive motor. This design is especially intended for mining work and general service in which pressures of from 200 to 600 pounds are necessary. Power is transmitted from the motor to the crank shaft by single-reduction gearing, thus reducing the working friction to a minimum, and making an extremely compact piece of apparatus. All gears are cut, thus increasing smoothness of action and lengthening life of pump. The belted pumps are furnished with one tight pulley. This pump, in common with the horizontal, triplex, outside plunger, double-acting type, has the following advantages: Steel connecting rods, outside packed plungers, "peg" type valve chambers, alleviators, compactness in construction, suction and discharge openings on either side, and adjustments on all wearing parts. For the armature shaft, we will furnish a fibre pinion to reduce the noise to a minimum, if specially ordered, at extra price, otherwise a cast-iron cut pinion will be furnished. The highest grade of material is used and great care is taken in the test of pump to prove there is no defect. In sending inquiries or orders always state as fully as possible the intended service and requirements.



Horizontal Triplex Power Pumps (Belt Driven).

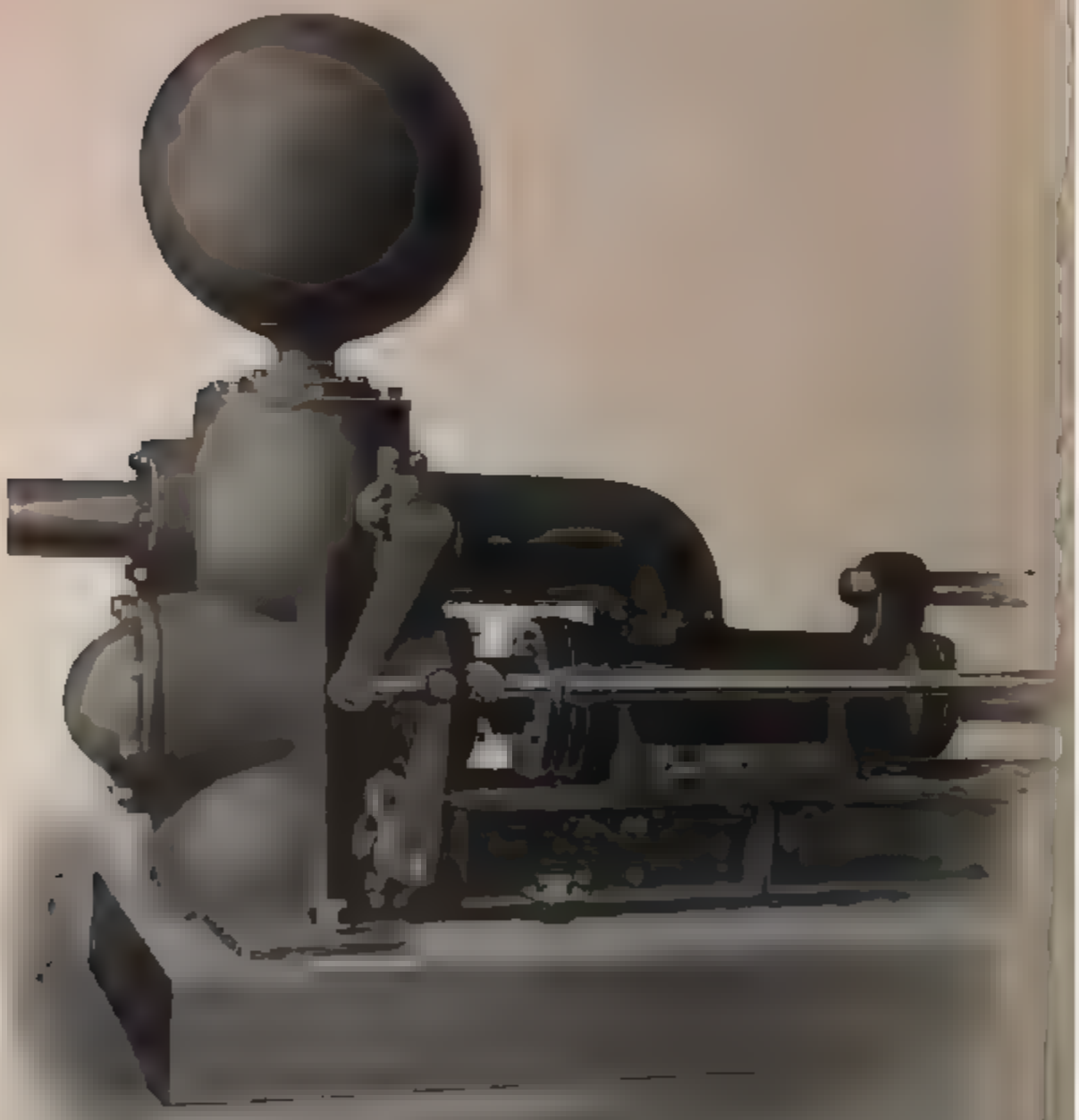


Horizontal Triplex Electric Pumps (Geared).

Diameter of Plungers.	Stroke	Maximum Lift in Feet	Revolutions per Minute.	Gallons per Revolution.	Gal'ons per Minute	Suction.	Discharge.	Pulley. Diam.	Pulley. Face.	Ratio of Pump Gears.	Ratio of Motor Gears.	H. P. Motor Required	Dimensions Over All Belted Pumps Not Arranged for Motor. A	B	C	Dimensions Over All. Arranged for Motor Geared A	B	C	Telegraphic Code Word. Belted Pumps Not Arranged for Motor.	Telegraphic Code Word. Electric Pumps, Geared. Arranged for Motor.
3	6	1250	74	.550	41	3	2	20	8	5 to 1	To Suit Speed of Motor.	20	5′ 7″	5′ 3″	8′ 4″	5′ 7″	6′ 7″	9′ 7″	Maggot	Docile
3½	6	750	74	980	72	4	3	20	8	5 to 1		20	6′ 9″	5′ 3″	8′ 4″	6′ 9″	6′ 7″	9′ 7″	Maggotish	Dolphin
4	6	500	74	1 380	102	5	4	20	8	5 to 1		20	6′ 9″	5′ 3″	8′ 4″	6′ 9″	6′ 7″	9′ 7″	Magianism	Donate
4½	6	440	74	1.530	113	5	4	20	8	5 to 1		20	6′ 9″	5′ 3″	8′ 4″	6′ 9″	6′ 7″	10′ 1″	Magiares	Dotage
5	8	750	58	2 468	143	6	4	36	10	5 to 1		50	8′ 1″	6′ 0″	10′ 4″	8′ 1″	7′ 4″	11′ 7″	Magicale	Dowel
5½	8	680	58	2.938	170	6	5	36	10	5 to 1		50	8′ 1″	6′ 0″	10′ 4″	8′ 1″	7′ 4″	11′ 7″	Magically	Dormer
6	8	550	58	3 446	200	6	5	36	10	5 to 1		50	8′ 1″	6′ 0″	10′ 4″	8′ 1″	7′ 4″	11′ 7″	Magician	Dough
6½	8	500	58	4.000	232	6	5	36	10	5 to 1		50	8′ 1″	6′ 0″	10′ 4″	8′ 1″	5′ 0″	11′ 11″	Magicorum	Doxy
8	8	380	58	5.220	303	8	5	36	10	5 to 1		50	8′ 6″	6′ 0″	10′ 4″	8′ 6″	8′ 0″	11′ 11″	Magidarum	Dovl

Pump End for a Knowles Single Horizontal Dif ential Plunger Pump,

With Mechanically Moved Pump Valves.



SIZE, 4¼" and 6" Plungers, 16" Stroke

[redacted]

Pump End for a Knowles Horizontal Differential Plunger Pump,

With Mechanically Moved Pump Valves.

THE cut shows one type of pump end of our single, differential plunger pump. The plungers are 4¼″ and 6″ diameter, respectively. Stroke of both is 16″. The pump valves are only two in number, one for the discharge and one for the suction. They are closed mechanically and positively at the instant the plungers reverse their stroke, by means of levers and connections operated by an eccentric on the crank shaft. By thus closing the valve, higher speed, less slip, and better duty can be obtained than with the ordinary valves now in use.

No mechanical attachment being provided to open the valves, they open at the beginning of the stroke by the pressure and flow of the water, remaining open practically the entire stroke.

The pump end shown by cut has been successfully operated at 150 revolutions per minute by mechanically closing the valves at the right time.

These valves are protected by letters patent granted July 2, 1895, and March 22, 1898.

The valve opening being large, all throttling of the water through the valve passages is avoided. Closing the valve at the proper moment prevents all slip and allows the pump to be run at any desired piston speed.

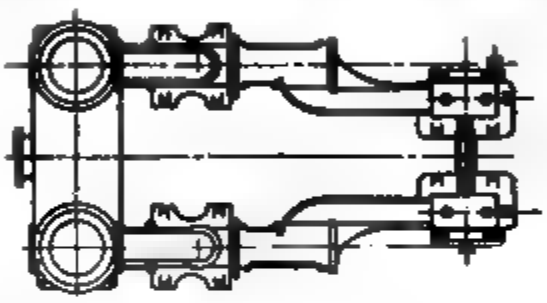
We make several types having mechanically moved valves as follows:— Single, duplex, and triplex single-acting; single, duplex, and triplex differential, or double-acting.

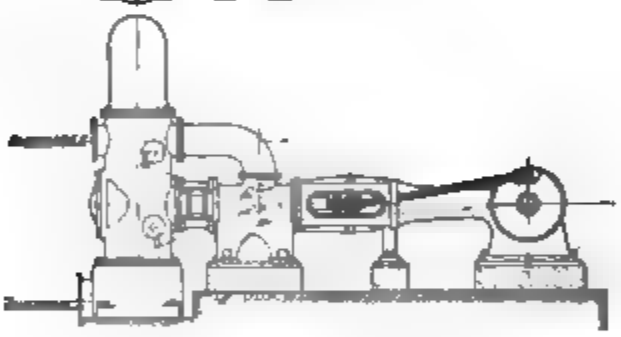
All parts are of materials best suited for the purpose. The workmanship is the best of its class, and the parts are well designed.

See page 137 for questions when sending inquiries or orders.

Single Differential Plunger Pumps.

Size. Large Plunger.	Size. Small Plunger.	Stroke	Revolutions per Minute	Gallons per Minute	Suction.	Discharge	H. P. at Pump End.	H. P. at Shaft 70% Efficiency.	Load on Pump End, Lbs	Dimensions Over All. Length.	Width	Height.	Telegraphic Code Word
5½	3⅜	24	120	395	8	6	37	855	2550	16' 0"	5' 10"	6' 6"	Higgir
7	5	24	120	480	10	8	68	125	4240	16' 4"	6' 6"	7' 6"	Highway
8½	6	24	120	705	10	8	88	125	6120	16' 9"	7' 4"	9' 0"	Hilarate
10	7½	24	120	980	12	10	125	180	8600	17' 6"	9' 6"	11' 0"	Hilding





The cut shows the duplex type. The single pump is practically one-half the duplex, with outboard bearing for the main shaft.

Knowles Duplex Differential Plunger Pumps.

Size. Large Plunger	Size. Small Plunger.	Stroke	Revolutions per Minute	Gallons per Minute	One Suction Open & Two Discharge Openings		H. P. at Pump End.	H. P. at Shaft. 70% Efficiency	Load on Pump End One Side Lbs	Dimensions Over All. Length.	Width.	Height.	Centres.	Telegraphic Code Word
5½	3½	24	120	590	10	6	74	105	2550	16' 0"	7' 0"	6' 6"	4' 9"	Hiatus
7	5	24	120	960	12	7	130	170	4240	16' 4"	8' 0"	7' 6"	5' 0"	Hibernal
8½	6	24	120	1410	14	8	175	250	6120	16' 9"	8' 10"	9' 0"	5' 9"	Hiccough
10	7½	24	120	1960	16	10	245	360	8600	17' 6"	9' 6"	11' 0"	6' 6"	Hickwall

Knowles Single and Duplex Differential Plunger Pumps,

With Mechanically Moved Pump Valves. For 500 Feet Lift.

THE outline drawings shown on opposite page illustrate other types of our single and duplex differential plunger pumps having mechanically moved pump valves.

The single pump is practically one-half a duplex pump, made so that, should a duplex be wanted for future requirements, the other half can be supplied, necessitating but very few changes.

These, like our other types, may be driven by gearing, belting, or rope transmission, or direct connected to motor.

Where convenient, we prefer belting or rope driving to gearing, as more quiet running results; and cost of repairs is generally much less.

In many cases the pump may be run directly from the driving shaft, and thus the intermediate gearing, belting, or rope transmission avoided.

The tables give sizes, space occupied, etc., by these types; but, should further information, not given here, be desired, we solicit correspondence.

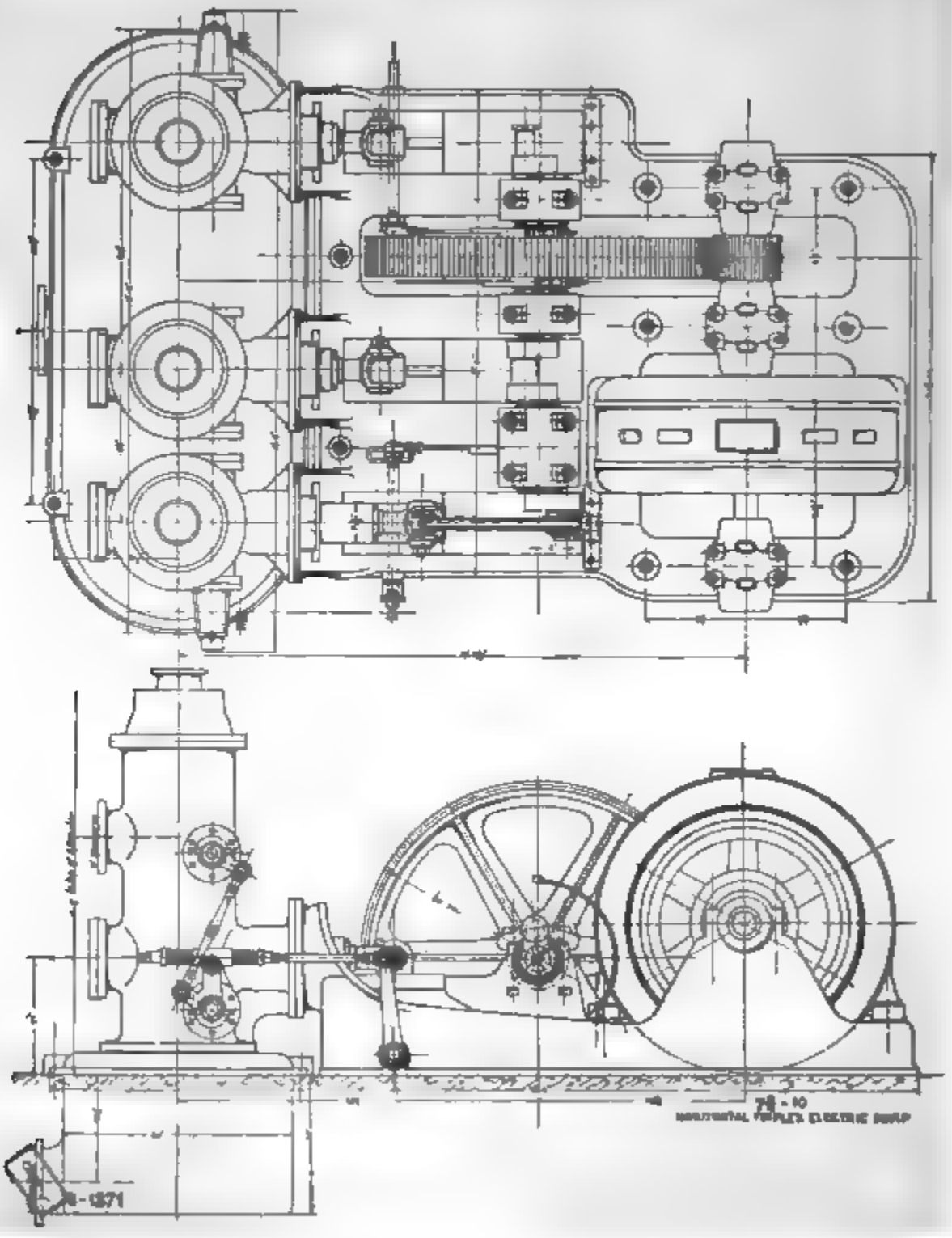
The lift of an ordinary valve is considerably less than our patent valve, and in most cases a large number of valves being used, the water is forced to flow through a great many separate and contracted valve passages. This largely increases the friction, due to partial throttling of the water. In other words, there is less loss by friction in water flowing through one valve of large area than there is in water flowing through a number of smaller valves of the same total area.

Each case generally developes many characteristic features, and only a careful study of all of the conditions can lead to the most satisfactory results; therefore we omit standard dimensions, and solicit correspondence regarding further details.

See page 137 for questions when sending inquiries or orders.

NOTE:—The figures in tables are for a piston speed of 480 feet. Horse-power at shaft is figured on 70% efficiency.

Knowles Horizontal Triplex Electric Pump



ith Mechanically Moved Pa

[illegible] x 10.

Knowles Horizontal Triplex Electric Pumps.

Single-Acting, with Mechanically Moved Pump Valves. For Lifts up to 500 Feet.

THE outline drawing on opposite page illustrates one of our horizontal, triplex, single-acting electric pumps having mechanically moved valves. This machine as a whole is compact and of rigid construction. It is connected to a 75 horse-power motor by gearing.

On each pump cylinder is placed an "alleviator" of special design for maintaining a uniform discharge pressure. (This is not shown in outline drawing; see outline drawing of the double-acting type.)

The valves are operated mechanically. In this type of pump there are six, one suction and one discharge valve for each cylinder. Each valve has another feature not mentioned before; *i.e.*, it is provided with an inner or auxiliary valve which is intended to relieve the main valve.

The valve seats are so constructed and arranged that the seat of the suction valve can be inserted or removed through the hole for the seat of the discharge valve. This is an advantage, as all seats are easily accessible and can be removed by a crane from above.

Suitable provision is made in these different types to prevent accident resulting from any obstructions which may be met during the closing of the valves.

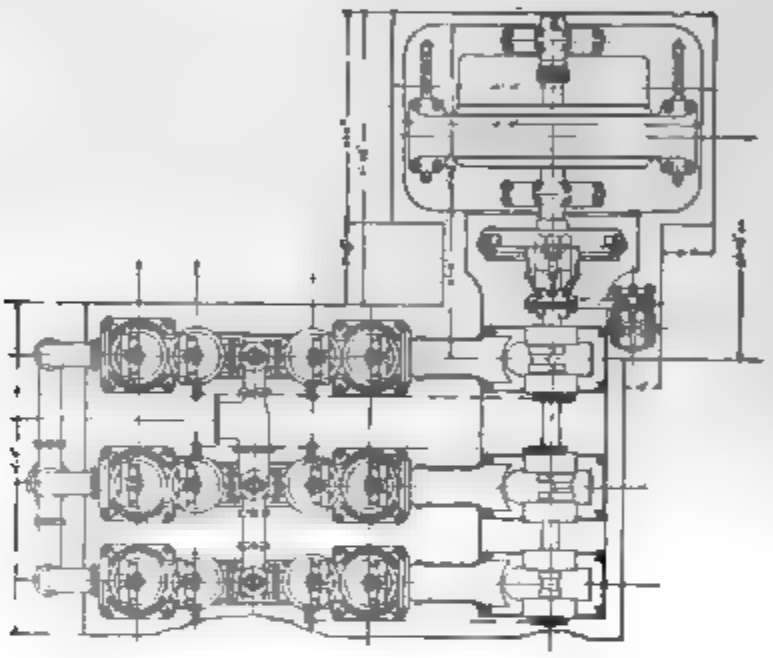
In large pumps a cast-iron guide is sometimes furnished, according to design, on which the differential plunger crosshead works, this crosshead being provided with a shoe.

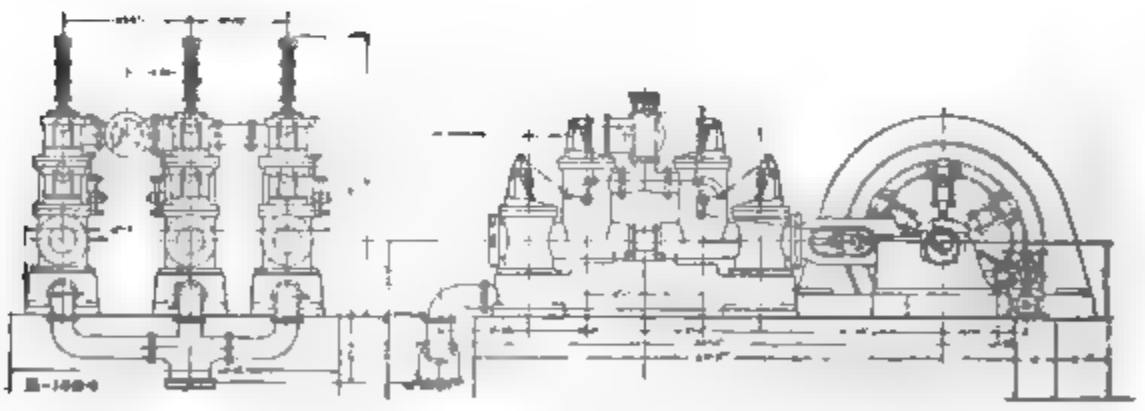
All working parts of these several types will be provided with efficient means of lubrication and adjustment for wear.

☛To avoid delays, please answer questions in list as fuliy as possible when sending inquiries or orders. (See page 137.)

Standard dimensions are omitted, as we prefer to submit specifications to suit each case.

Knowles Horizontal Triplex Electric Pum





Double-Acting, with Mechanically Moved Pump Valves.

SIZE, 10 x 15.

[redacted]

Knowles Horizontal Triplex Electric Pumps.

Double-Acting, with Mechanically Moved Pump Valves. For Lifts up to 500 Feet.

THE outline drawing on opposite page illustrates a somewhat different type of pump from the others, which is double-acting. The pump crank shaft is directly connected to a 500 horse-power motor by a clutch. We furnish these clutches for electric plants with alternating current where there is not sufficient torque to start the pump. The clutches are specially made so that the motor can be started independently of pump, and when the required speed is reached the clutch is thrown into place.

Where there is a sufficient starting torque for motor no clutch is necessary; a water relief, or by-pass valve is used to relieve the pressure on the pump sufficiently to equal the starting torque of motor. Therefore, when starting up, water is circulated through by-pass until motor comes to speed, when a gate valve is closed, throwing the load gradually on the pump.

The mechanically moved valves have a higher lift than the ordinary valves and an area sufficiently large to reduce the speed of the water flowing through same to but a few feet per second.

In a single, double-acting pump, four valves are required, one suction and one discharge valve for each end of the double-acting plunger. A single differential pump, however, requires but one suction and one discharge valve for but one of the plungers, the main plunger.

Because of having half the number of valves, this form of pump is simpler than the double-acting pump, and is used until the capacity becomes so great that the valves would be too cumbersome. When this capacity is reached it becomes necessary either to make a duplex or triplex pump with differential plungers, or to use a double-acting pump instead. The double-acting pump valve would be half the size of the differential pump valve for the same total capacity.

The pump cylinders are provided with an "alleviator" of special design, for maintaining a uniform discharge pressure. (These are shown in end elevation of outline drawing on opposite page.)

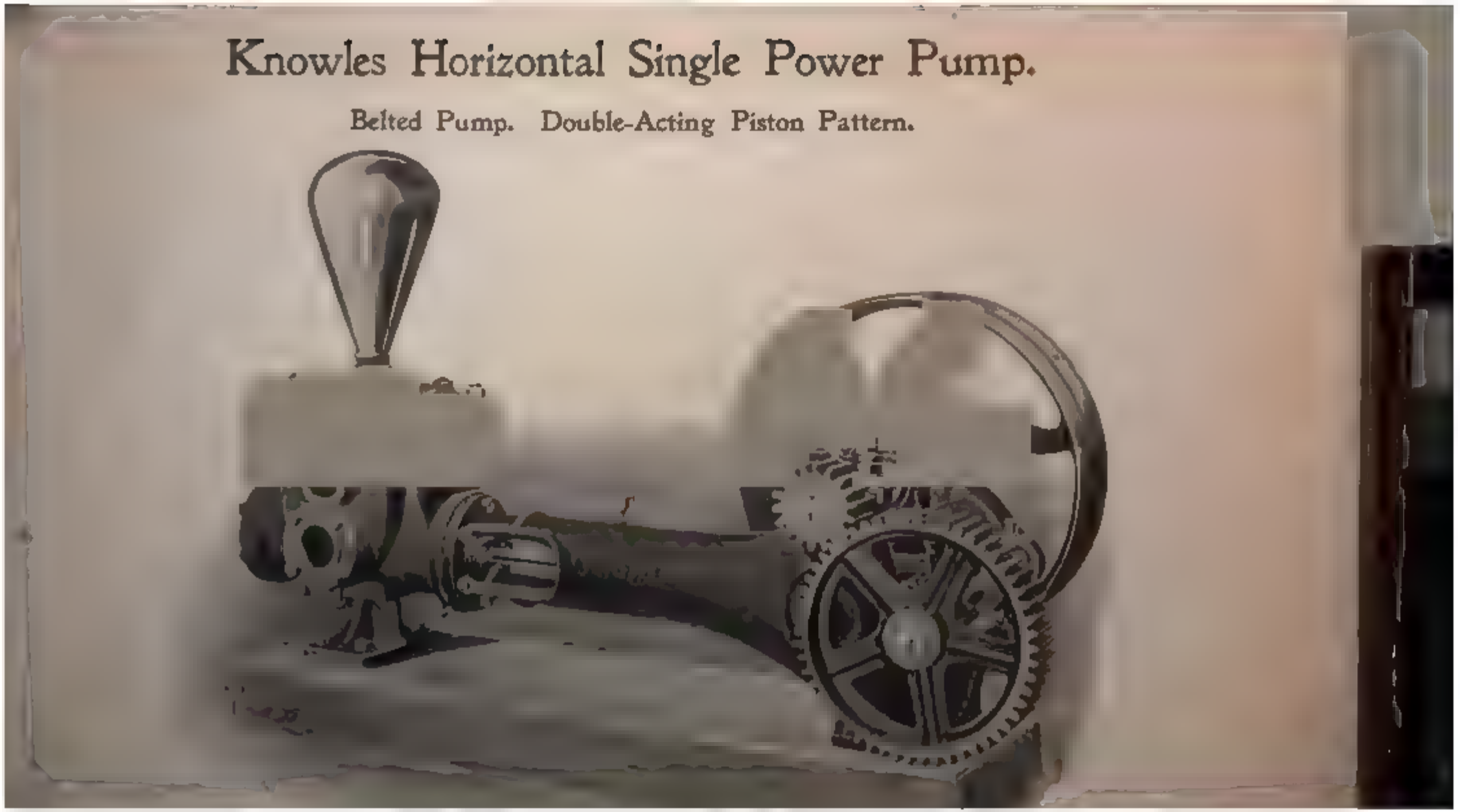
We omit standard dimensions and solicit correspondence in regard to this type.

If in doubt which power it is best to install, we shall be pleased, upon receipt of a statement of the conditions, to make proper estimates.

See page 137 for questions when sending inquiries or orders.

Knowles Horizontal Single Power Pump.

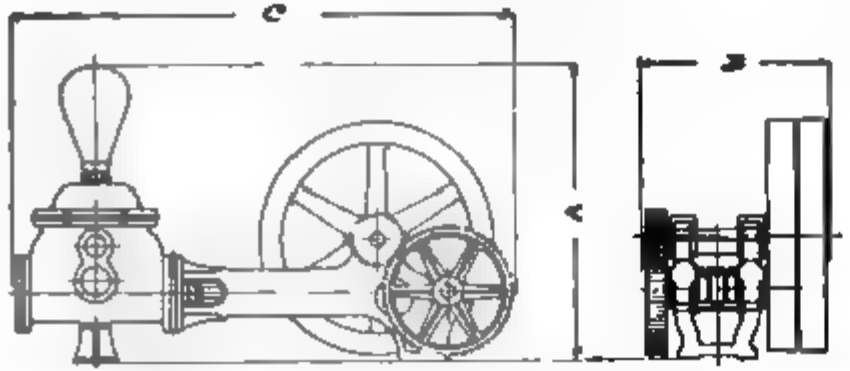
Belted Pump. Double-Acting Piston Pattern.



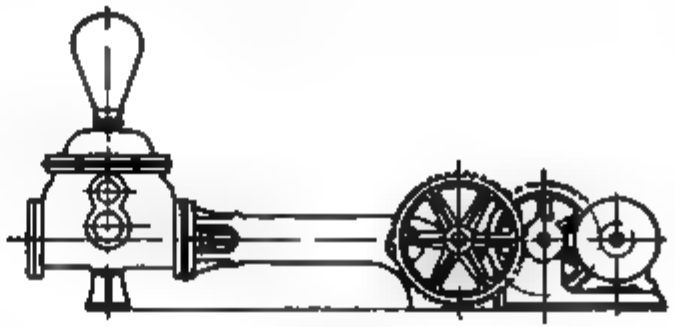
Double-Acting Piston Pattern.

THE cut on opposite page shows one of our power pumps double acting, single cylinder pattern, fitted with gears. We also make a similar pump designed to be driven directly by belt without intermediate gearing. This style of pump has suction and discharge valves above the cylinder barrel, and is designed either for 50 or 100 pounds pressure per square inch, according to requirements. Adjustments are provided for all bearings, slides, and other parts subjected to wear. Every part is carefully proportioned and the material and workmanship are the very best obtainable. All gears and pinions have machine-cut teeth. The pistons are suitably packed for hot or cold water or other liquids. For belted pumps tight and loose pulleys are furnished. The electric type requires changes in gears, base, etc., according to size, type, and speed of motor used, therefore we omit the usual table of "standard" dimensions, preferring to submit proper specifications.

We have patterns also for power pumps arranged with inside or outside plungers, suitable for gritty or bad water. When sending inquiries or orders, always state the pressure against which pump will have to work.



Belt-Driven Power Pumps, Single-Cylinder Pattern, Double-Acting.



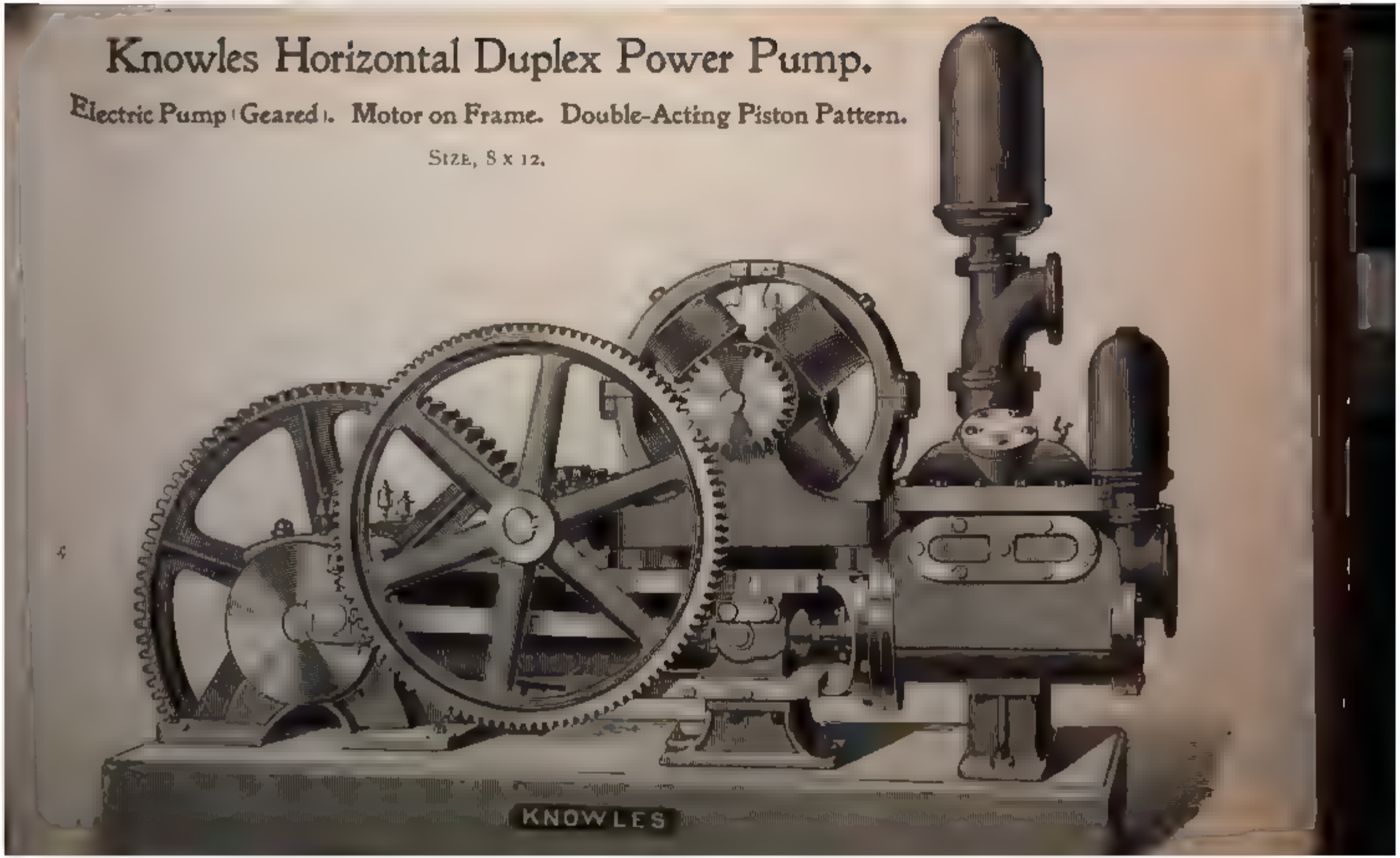
Electric, Geared Power Pumps, Single-Cylinder Pattern, Double-Acting.

Diameter of Piston	Stroke	Revolutions per Minute.	Gallons per Revolution.	Gallons per Minute	Suction.	Discharge	Pulleys Tight and Loose: For 50 lbs. Press. Diam	Face	For 100 lbs. Press. Diam	Face	Ratio of Pump Gears.	Ratio of Motor Gears.	H. P. Motor Required: For 50 lbs. Press.	For 100 lbs. Press.	Belted Pumps Not Arranged for Motor. Dimensions Over All. For 50 lbs. Pressure: A	B	C	For 100 lbs. Pressure: A	B	C	Telegraphic Code Word. Belted Pumps: For 50 lbs. Pressure.	For 100 lbs. Pressure.	Electric Pumps: For 50 lbs. Pressure.	For 100 lbs. Pressure.
3	6	90	.367	18 35	2	1¼	16	3	24	3	3 to 1	To Suit Speed of Motor	½	¾	3' 4"	20"	4' 0"	3' 4"	20"	4' 0"	Macroale	Elusion	Macuba	Madcap
3½	6	80	.430	21 50	2	1½	16	3	24	3	3 to 1		¾	1	3' 4"	20"	4' 0"	3' 4"	20"	4' 0"	Macrouro	Elosive	Maculammo	Maddalcone
3½	6	70	.373	26 05	2	1¾	24	3	36	3	3 to 1		1	1½	3' 10"	20"	4' 5"	3' 10"	20"	4' 5"	Macroutous	Elusory	Maculatum	Maddened
4	6	60	.653	32 60	2½	2	24	3	36	3	3 to 1		1½	2	3' 10"	20"	4' 5"	3' 10"	20"	4' 5"	Macroxus	Eluted	Maculaset	Maddening
3½	10	80	.718	34 46	2½	2	16	3	24	3	3 to 1		2	3	3' 10"	3' 1"	5' 6"	3' 10"	3' 1"	5' 6"	Macroramie	Eluting	Maculatore	Madehat
3½	10	60	.956	45 88	2½	2	16	3	24	3	3 to 1		3	5	3' 10"	3' 1"	5' 6"	3' 10"	3' 1"	5' 6"	Macruerust	Eluxate	Maculavamo	Madehurst
4½	10	60	1 57	55 53	3	2½	18	3	30	3	3 to 1		3	5	3' 10"	3' 1"	5' 6"	3' 10"	3' 1"	5' 6"	Macrustl	Elvan	Maculavate	Madecease
4½	10	48	1 770	55 09	3	2½	18	3	30	3	3 to 1		4	7	3' 10"	3' 1"	5' 6"	3' 10"	3' 1"	5' 6"	Macrural	Elvish	Macule	Madefacean
5	10	48	1 770	81 60	3	2½	18	3	30	3	3 to 1		5	9	3' 1"	3' 1"	5' 6"	3' 1"	3' 1"	5' 6"	Macrynea	Elysian	Maculerai	Madefacing
5	12	60	2 45	117 48	4	4	36	4	48	6	3 to 1		6	11	3' 8"	3' 8"	6' 5"	3' 8"	3' 8"	7' 0"	Macsurah	Emaciate	Maculeries	Madefactel
5	12	60	3 98	139 93	5	5	30	4	48	6	3 to 1		8	16	3' 9"	3' 8"	6' 5"	3' 9"	3' 8"	7' 0"	Mactabamus	Emanate	Maculero	Madefactos
6	12	60	5 22	208 80	5	5	36	6	56	8	3 to 1		10	18	3' 9"	3' 9"	6' 7"	3' 10"	3' 9"	7' 5"	Mactabant	Embale	Maculerous	Madefatto
7	12	60	8 80	304 30	6	8	48	6	56	8	3 to 1		14	26	4' 1"	3' 9"	7' 2"	4' 1"	3' 9"	7' 8"	Mactabile	Embalmer	Maculeux	Madefecero
8	12	60	11 16	386 90	6	8	48	6	60	8	3 to 1		16	32	4' 1"	3' 9"	7' 2"	4' 1"	3' 9"	7' 8"	Mactabita	Embank	Maculosa	Madefecia

Knowles Horizontal Duplex Power Pump.

Electric Pump (Geared). Motor on Frame. Double-Acting Piston Pattern.

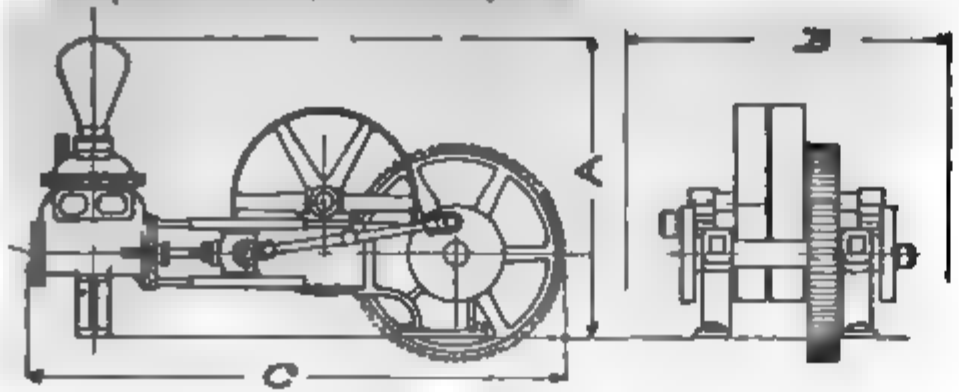
SIZE, 8 x 12.



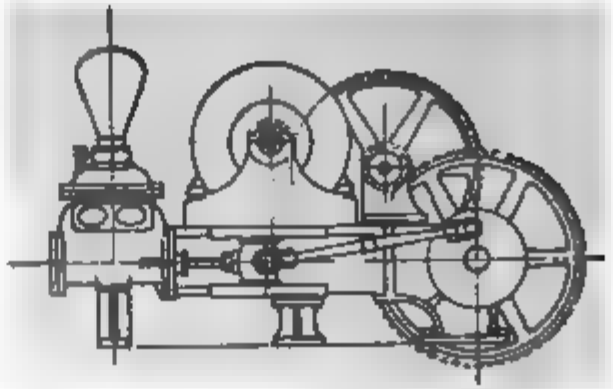
directly to the jack shaft of a turbine or water-wheel, driven by belt or gear connection from line shafting, or electrically operated by motor placed on top or at end of pump. This style is designed either for 25, 50, or 130 pounds pressure per square inch, according to requirements. Adjustments are provided for all bearings, slides,

tion of motor used; therefore, we omit the usual table of "standard" dimensions for electric pumps, preferring to submit proper specifications.

In sending inquiries or orders, always state as fully as possible the intended service and requirements.



Duplex Power Pumps, Double Acting Piston Pattern, Belt Driven.



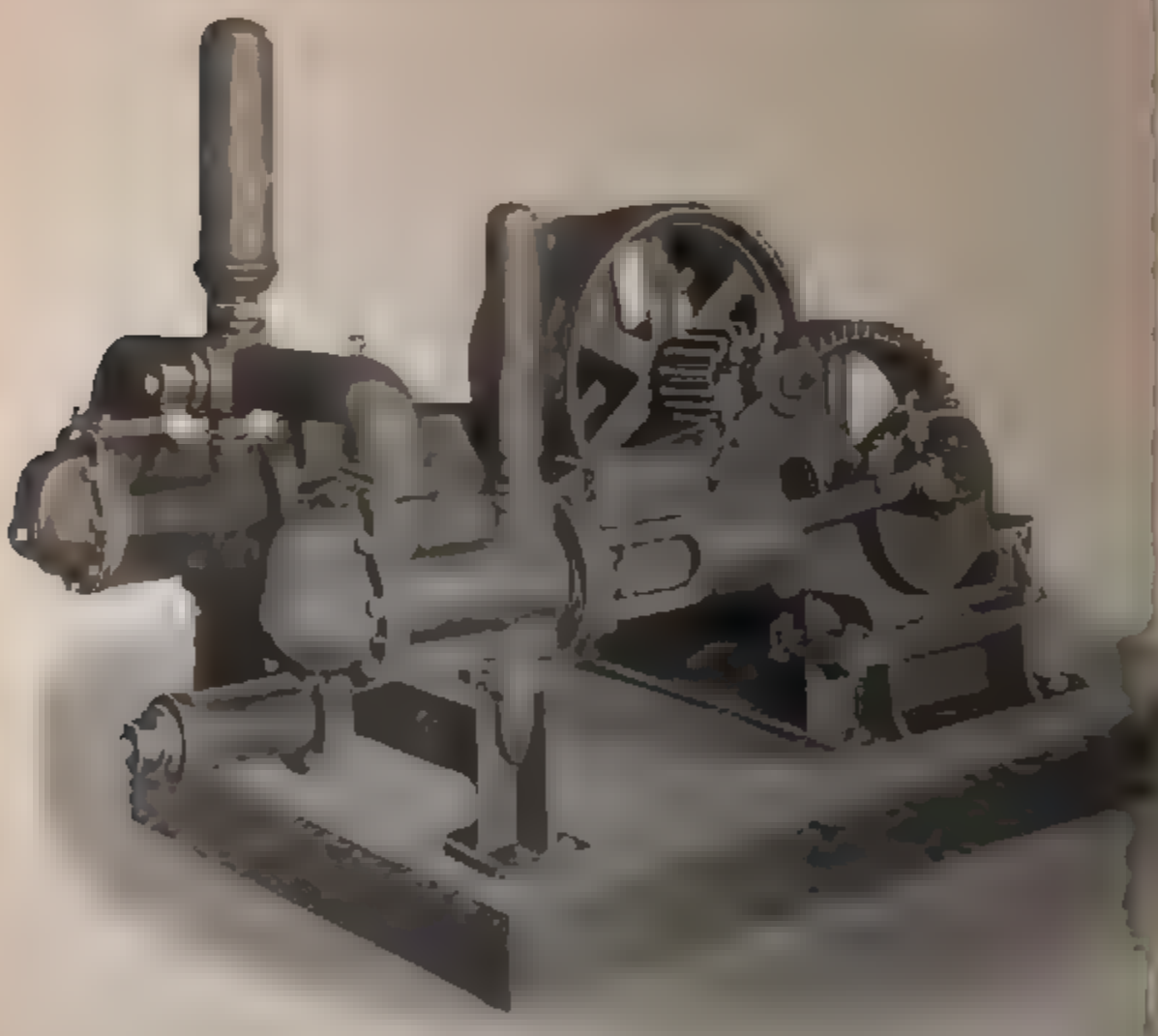
Duplex Electric Power Pumps, Double-Acting Piston Pattern.

Diameter of Pumps	Strokes	Revolutions per Minute	Gallons per Revolution	Gallons per Minute	Suction	Discharge	Pulleys Tight and Loose * For 25 lbs. Pressure: Diam.	Face	For 50 lbs. Pressure: Diam.	Face	For 130 lbs. Pressure: Diam.	Face	Ratio of Pump Gears	Number of Motor Gears	H. P. Motor Required: For 25 lbs. Pressure	For 50 lbs. Pressure	For 130 lbs. Pressure	Belted Pumps Not Arranged for Motor: Dimensions Over All. For 25 lbs. Pressure: A	B	C	For 50 lbs. Pressure: A	B	C	For 130 lbs. Pressure: A	B	C	Telegraphic Code Word. Belted Pumps. For 25 lbs. Pressure.	For 50 lbs. Pressure.	For 130 lbs. Pressure.	Electric Pumps. For 25 lbs. Pressure.	For 50 lbs. Pressure.	For 130 lbs. Pressure.
3	6	50	1.102	55	3	3	10	3	11	3	12	4	5 to 1	To Suit Speed of Motor.	3	5	11	4' 0"	3' 0"	3' 0"	4' 0"	3' 0"	3' 0"	4' 0"	3' 0"	3' 0"	Madwort	Madrona	Madsel	Maudel	Maunder	Maurage
3	7	50	1.378	69	3	4	10	4	11	4	13	5	6 to 1		4	6	13	4' 0"	3' 0"	3' 0"	4' 0"	3' 0"	3' 0"	4' 0"	3' 0"	3' 0"	Madgrave	Madreacre	Madsmear	Maudlen	Maundrels	Maurgelle
3	8	50	1.654	83	3	4	10	4	11	4	13	5	7 to 1		5	7	15	4' 0"	3' 0"	3' 0"	4' 0"	3' 0"	3' 0"	4' 0"	3' 0"	3' 0"	Madmen	Madrobe	Madsore	Maugfete	Maundrew	Maurdling
4	8	50	2.448	122	4	4	12	4	13	4	15	5	5.75 to 1		5	8	20	4' 0"	4' 0"	3' 0"	4' 0"	4' 0"	3' 0"	4' 0"	4' 0"	3' 0"	Madtress	Madrobtree	Madsetia	Maugdelve	Maunderam	Maurdorf
4	9	50	2.754	138	4	4	12	4	13	4	15	5	6.75 to 1		7	13	30	4' 0"	4' 0"	3' 0"	4' 0"	4' 0"	3' 0"	4' 0"	4' 0"	3' 0"	Madwydeen	Madrogne	Madsim	Maugdelvin	Maunderamm	Maurdroth
4	10	50	3.060	153	4	5	12	5	13	5	15	6	7.75 to 1		8	15	41	4' 0"	4' 0"	3' 0"	4' 0"	4' 0"	3' 0"	4' 0"	4' 0"	3' 0"	Madsaint	Madrogne	Madsetaram	Maugdelvine	Maunderbo	Maurdrill
4	11	50	3.366	168	5	5	14	5	15	5	17	6	8.75 to 1		11	21	56	4' 0"	4' 0"	3' 0"	4' 0"	4' 0"	3' 0"	4' 0"	4' 0"	3' 0"	Madsaipe	Madrolsive	Madsible	Maudder	Maundsale	Maurdlyd
4	12	50	3.672	184	5	5	14	5	15	5	17	6	9.75 to 1		12	23	70	5' 0"	4' 0"	3' 0"	5' 0"	4' 0"	3' 0"	5' 0"	4' 0"	3' 0"	Madsella	Madrolfrom	Madsradon	Maudelfrom	Maundsarum	Maurgamont
5	12	50	5.508	275	6	6	16	6	17	6	19	7	9.75 to 1		15	31	85	5' 0"	5' 0"	3' 0"	5' 0"	5' 0"	3' 0"	5' 0"	5' 0"	3' 0"	Madsbeam	Madroggin	Madsmile	Maudelsbee	Maundsee	Maurdlee
5	13	50	5.967	298	6	6	16	6	17	6	19	7	9.75 to 1		17	35	100	5' 0"	5' 0"	3' 0"	5' 0"	5' 0"	3' 0"	5' 0"	5' 0"	3' 0"	Madsdeetee	Madrople	Madsradbee	Maudsell	Maundsee	Maurdrath
5	14	50	6.426	321	6	6	16	6	17	6	19	7	9.75 to 1		19	40	115	5' 0"	5' 0"	3' 0"	5' 0"	5' 0"	3' 0"	5' 0"	5' 0"	3' 0"	Madsdeetram	Madroprel	Madsrave	Maudsell	Maundsee	Maurdrawn
6	14	50	8.568	428	7	7	18	7	19	7	21	8	9.75 to 1		25	52	145	5' 0"	5' 0"	3' 0"	5' 0"	5' 0"	3' 0"	5' 0"	5' 0"	3' 0"	Madsdeetrom	Madrorrin	Madsrian	Maudsetee	Maundsee	Maurdrawn
6	15	50	9.180	459	7	7	18	7	19	7	21	8	9.75 to 1		28	58	165	5' 0"	5' 0"	3' 0"	5' 0"	5' 0"	3' 0"	5' 0"	5' 0"	3' 0"	Madsdeetsam	Madrorrom	Madsrian	Maudsetee	Maundsee	Maurdrawn
6	16	50	9.792	490	7	7	18	7	19	7	21	8	9.75 to 1		31	64	185	5' 0"	5' 0"	3' 0"	5' 0"	5' 0"	3' 0"	5' 0"	5' 0"	3' 0"	Madsdeetsam	Madrorrom	Madsrian	Maudsetee	Maundsee	Maurdrawn
7	16	50	12.544	627	8	8	20	8	21	8	23	9	9.75 to 1		35	72	205	5' 0"	5' 0"	3' 0"	5' 0"	5' 0"	3' 0"	5' 0"	5' 0"	3' 0"	Madsdeetsam	Madrorrom	Madsrian	Maudsetee	Maundsee	Maurdrawn
7	17	50	13.328	666	8	8	20	8	21	8	23	9	9.75 to 1		39	80	230	5' 0"	5' 0"	3' 0"	5' 0"	5' 0"	3' 0"	5' 0"	5' 0"	3' 0"	Madsdeetsam	Madrorrom	Madsrian	Maudsetee	Maundsee	Maurdrawn
7	18	50	14.112	705	8	8	20	8	21	8	23	9	9.75 to 1		43	88	255	5' 0"	5' 0"	3' 0"	5' 0"	5' 0"	3' 0"	5' 0"	5' 0"	3' 0"	Madsdeetsam	Madrorrom	Madsrian	Maudsetee	Maundsee	Maurdrawn

* Tight and loose pulleys are furnished up to 12-inch face, inclusive. ^Over 12-inch face, tight pulley only is furnished.

Knowles Improved Duplex Electric or Pow
Brewers' Pump.

Belted Pump. Single-Acting Piston Pattern.



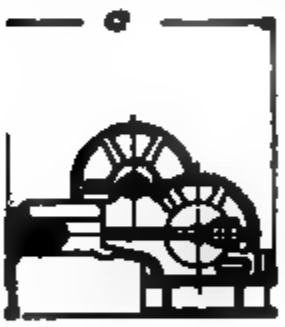
SIZE, 5 x 10

[redacted]

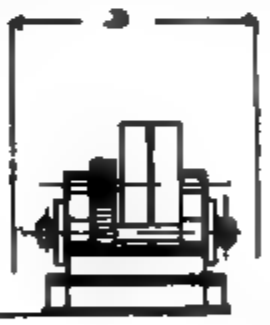
les Improved Duplex Electric or Power Brewers' Pump.

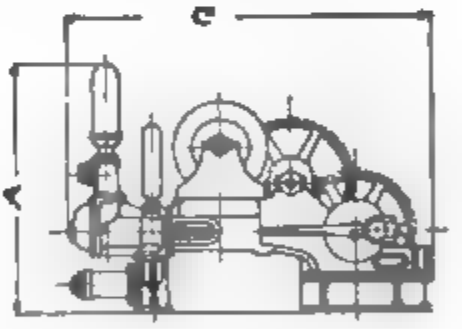
Single-Acting Piston Pattern.

e of pump is used in connection with the central tank beer-filling system. By exhaust-
periments made in the past it has been proven that many of the ordinary beer pumps
ite unfit for pumping fermented beers from storage casks without air pressure This
the large clearances exisiting in the ports and passages of beer pumps as heretofore
d. It is a well-known fact that beer will not flow through a pipe with the same freedom
a little friction as water, owing to its viscosity, and a pipe or hose filled with beer foams
the passage of clear beer even when under considerable pressure. When pumping
rage cask without air pressure a partial vacuum must be maintained in the suction
s fall of pressure liberates considerable carbonic acid gas, the quantity increasing
h a high vacuum, and this gas partially filling pipe and passages of pump, reduces their
ng capacity. The gas accumulating in this manner expands as the piston recedes and
e cylinder from filling through the suction valves. This cannot be remedied by increas-
e of the suction pipe, for a certain velocity must be maintained to give satisfaction.
olved the problem by making the pump a gas compressor as well as a beer pump, and
the pipes from fermented beer compressed air is forced through the entire system,
y with the annoyance of pumping hot water through the pipe line. The pump is duplex
each cylinder being single-acting and having but two valves one in the piston and one
der head. The beer enters at the bottom, passes through the cylinder in a straight
taken off at the opposite end on top, there being no sharp corners to turn nor crooked
cted passages to follow. The motion of the beer never being reversed, foaming is
with. The pistons run close to the cylinder heads, therefore all gas is expelled from
er, to be absorbed by the beer under pressure in the delivery pipe The cylinders are
d, pistons and valves are of composition, piston rods of bronze, and all parts are made
ost of material. Each pump is furnished with a suction and discharge air chamber.
ups are furnished with tight and loose pulleys. The motor for the electric type may be
top or end of pump. But owing to the peculiar design of this type of pump, it is desir-
ange the cylinders and auxiliary parts to correspond with the size, type, speed, and
motor used; therefore we omit the usual table of "standard" dimensions for electric
eferring to submit proper specifications. The electric type specially commends itself to
ractice, for the reason that the power may be applied at will wherever needed in the
ese pumps are very strong and durable and deliver the full rated capacity regardless
el of beer in the storage cask The sizes given in table are suited for 50 pounds beer
nd 80 pounds air pressure. In sending inquiries or orders, always state as fully as
e intended service and requirements.



Horizontal Duplex Power Brewers' Pump (Belt Driven).



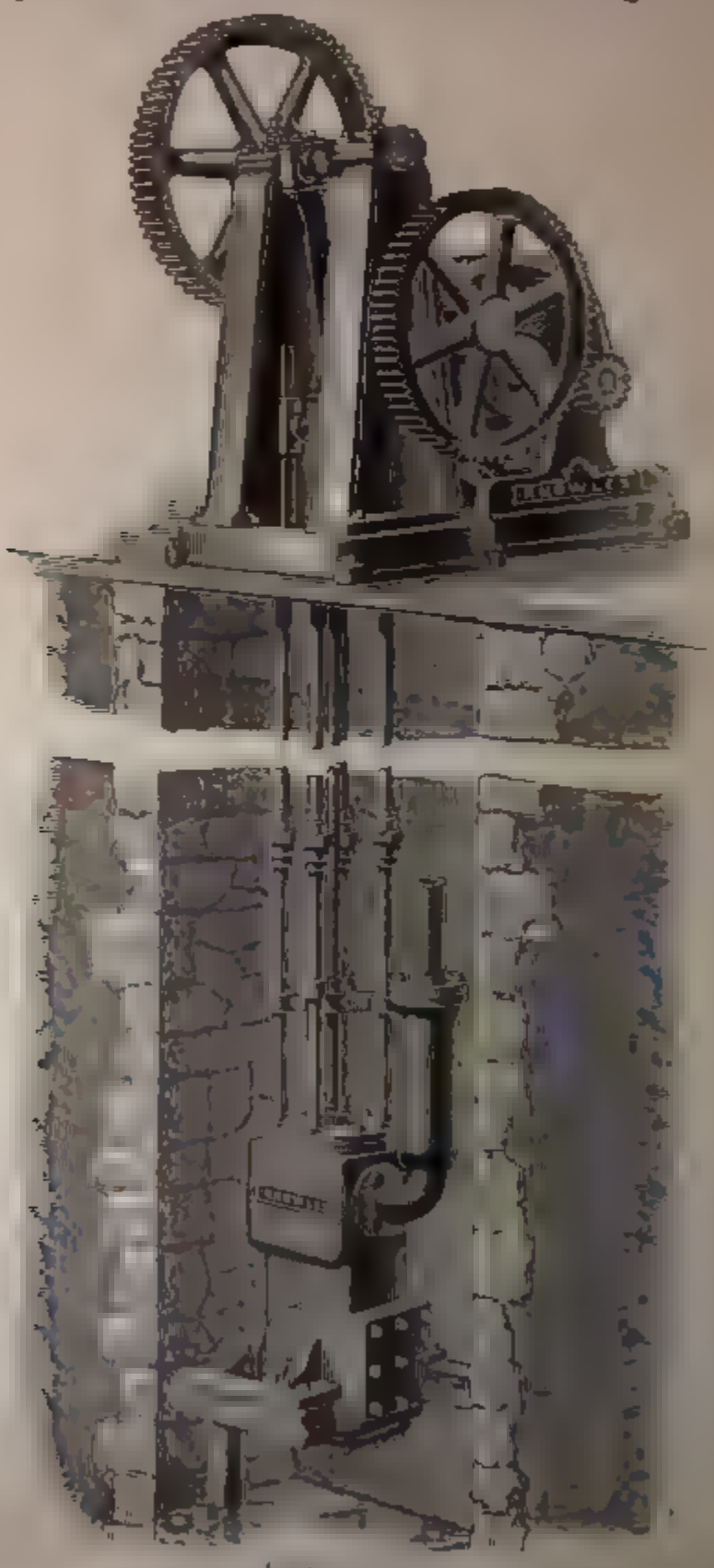


Horizontal Duplex Electric Brewers' Pump (Geared).

Revolution.	Gallons per Minute	Suction	Discharge	Pulleys, Tight and Loose. Diam	Pulleys, Tight and Loose. Face.	Ratio of Pump Gears.	Ratio of Motor Gears	H P Motor Required	Dimensions Over All. Belted Pumps Not Arranged for Motor A	B	C	Telegraphic Code Word. Belted Pumps Not Arranged for Motor.	Telegraphic Code Word. Electric Pumps. Geared. Arranged for Motor.
70	68.0	4	4	30	7	3.5 to 1	To suit Speed of Motor	4	5' 6"	4' 7"	7' 6"	Malerkiti	[redacted]
125	98.0	4	4	30	7	3.5 to 1		5	5' 6"	4' 7"	7' 6"	Malerkolik	Malesnadi
175	133.2	5	5	[redacted]	7	3.5 to 1		7½	5' 8"	5' 0"	8' 0"	Malerkunst	Malesnados
250	174.0	5	5	[redacted]	7	3.5 to 1		10	5' 8"	5' 0"	8' 0"	Malerlack	Maletines

Knowles Power Deep Well Pump.

Electric Pump (Geared). Vertical, Double-Acting, Piston Pat

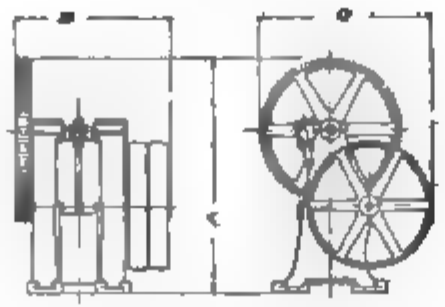


Size, 7 x 12.

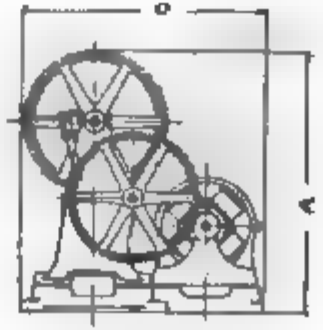
the vertical pattern, as illustrated, or of the horizontal type, with heavy cast-iron bed-plate, to which the guide frame and discharge pieces are bolted. The "working-head" is arranged for bolting to woodwork at the mouth of the well or shaft, the tie-rods and pump rod being made of proper length to suit the conditions of each case. The crosshead guide forms a tie between frames, making the "working head" of exceptional strength and rigidity. The connecting rod is of steel, having adjustable babbitted box on crank end, crosshead end being solid with brass bushing. The crank shaft is in one piece and works in ample babbitted bearings. The crank shaft, connecting rod and bearings are designed for severe service, the gears are machine cut, the tie-rods and guides are proportioned to the work to be performed. The valve seats, valve bolts, etc., of the water cylinder are made of the best composition. The water piston is also made of composition and arranged with adjustable packing, making the water end practically "rust proof." Belted pumps are furnished with tight and loose pulleys, tight pulley is used as a balance-wheel, and is made extra heavy. On electric pumps the intermediate gear is made extra heavy and is used as a balance-wheel. The extended bed-plate, for the electric type, is designed especially to receive the specified size and type of motor. Connections between "working head" and pump cylinder, to suit any depth of well or shaft, furnished at extra price, when specially ordered. All material is of the highest grade, and great care is taken in the test to prove there is no defect. In sending inquiries or orders, always state as fully as possible the intended service and requirements.

Pump Ends.

Diameter.	Stroke.	Revs. per Min.	Gallons per Revolution.	Gallons per Minute.	Suction.	Discharge.	Telegraphic Code Word.
4	10	40	1.085	43.52	2½	2	Magnify
4	12	40	1.305	52 20	2½	2	Magnifying
4	16	30	1.740	52 20	2½	2	Magniloco
5	10	40	1.70	68 00	3	2½	Magnissimo
5	12	40	2.04	81.60	3½	3	Magnitas
5	16	30	2.72	81 60	3½	3	Magnitatem
6	10	40	2 448	97 92	3½	3	Magnitatis
6	12	40	2 937	117 48	3½	3	Magnitude
6	16	30	3.916	117.48	3½	3	Magnoabi
7	12	40	4.000	160	4	3½	Magnoc
7	16	30	5.32	160	4	3½	Magnopere
8	12	40	5.22	208.88	5	4	Magnopolis
8	16	30	6.962	208.88	5	4	Magnorum
10	12	40	8.16	326 40	8	6	Magofoma
10	16	30	10.88	326.40	8	6	Magoma



Belted Power Working Head.
For operating Deep Well Double-Acting Piston Pumps.



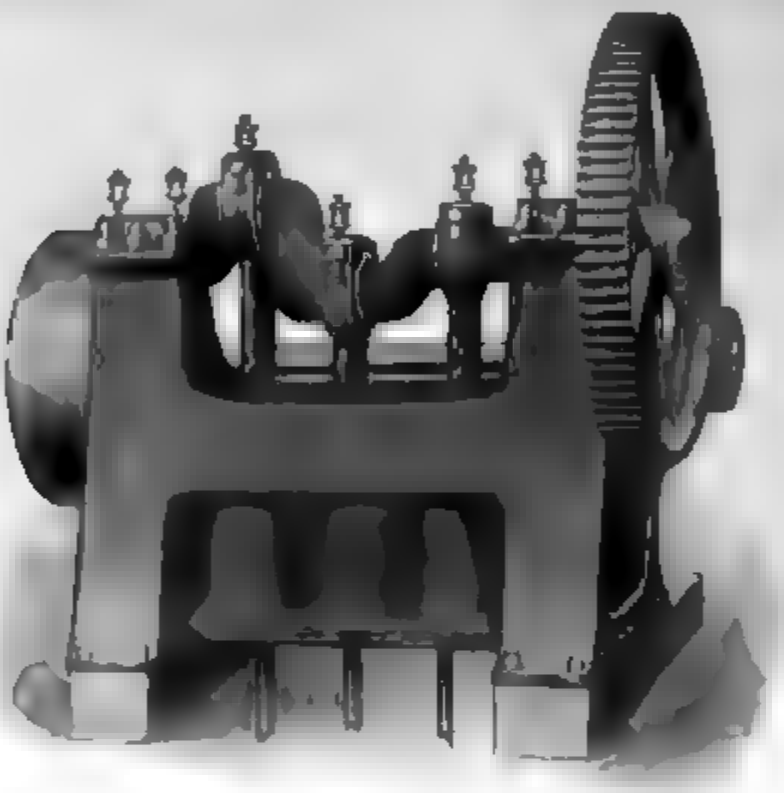
Electric Power Working Head.
For operating Deep Well Double-Acting Piston Pumps.

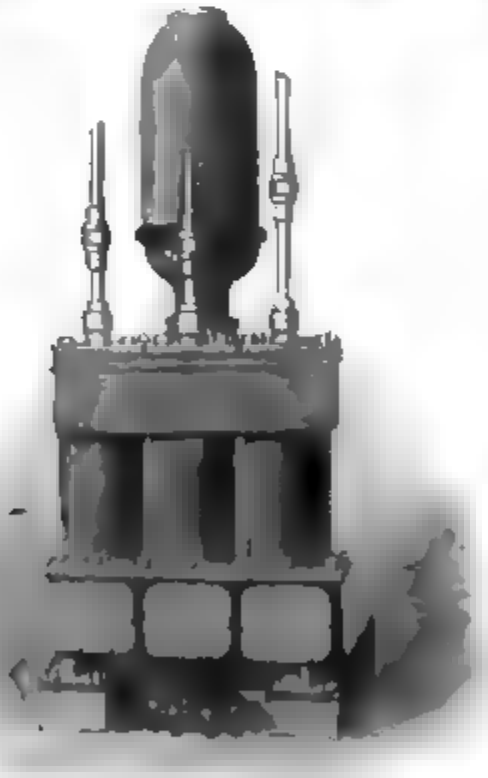
Working Heads

Stroke.	Revolutions per Minute	H. P. Motor Required.	Size of Pump End for Following Heads: 50 Feet.	75 Feet	125 Feet	150 Feet	Ratio of Gears.	Pulleys, Tight and Loose: Diam	Face.	Dimensions Over All Power Head Not Arranged for Motor: A	B	C	Dimensions Over All Power Head Arranged for Motor Geared: A	B	C	Telegraphic Code Word. Power Head Not Arranged for Motor.	Power Head Arranged for Motor. Geared.
10	40	3-5	6x10	4x10			5 to 1	24	4	4' 10"	3' 2"	3' 5"	5' 2"	3' 6"	4' 10"	Magsame	Magulum
12	40	4	6x12	4x12			5 to 1	30	5	5' 0"	3' 4"	3' 8"	5' 7"	3' 8"	4' 10"	Maguglio	Maguntia
12	40	10	8x12 / 10x12	7x12	6x12	5x12	5 to 1	36	6	5' 6"	3' 6"	3' 11"	5' 7"	3' 10"	5' 0"	Magulis	Maguntinas
16	30	4	6x16	4x16			5 to 1	36	5	5' 4"	3' 4"	4' 0"	6' 0"	3' 8"	5' 6"	Magulladas	Maguntino
16	30	10	8x16 / 10x16	7x16	6x16	6x16	5 to 1	42	6	5' 6"	3' 6"	4' 5"	6' 2"	3' 10"	5' 8"	Magullamos	Magus

Knowles Vertical Triplex Power Pum

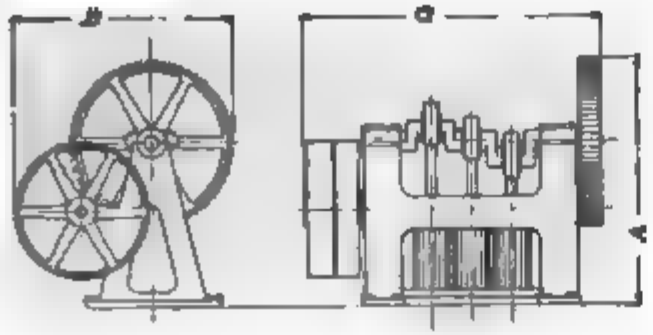
For Deep Open Wells. Belted Pump. Single-Acting Bucket Pattern.



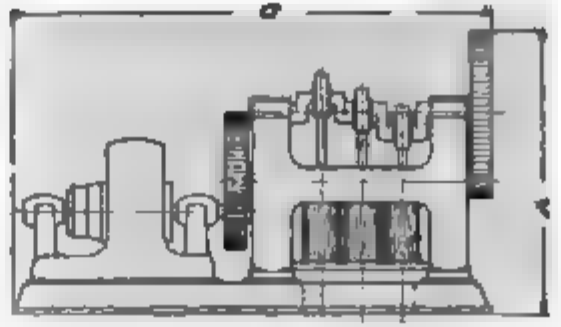


SIZE, 6½ x 8.

the frame gives very rigid construction and perfect alignment. The pump cylinders are supported by beams in the well, and being cast together, with valve chest bolted on, makes a very self-contained pump end. Rods connecting pump end, guides, etc., vary according to the depth of well. The connecting rods are steel, having adjustable babbitted box on crank end, crosshead end being solid with brass bushing. The crank shaft is in one piece and works in ample babbitted bearings. All parts are designed for severe service, wearing parts being provided with adjustment for chamber being furnished on pump end of both belted and electric type. The extended bed-plate, for the electric type, is designed especially to receive the specified type and size of motor. A pinion of fibre will be furnished for the armature shaft, so as to reduce the noise to a minimum, if specially ordered, at extra price; otherwise a cast-iron cut pinion will be furnished. All material is of the highest grade, and great care is taken in the test to prove there is no defect. In sending inquiries or orders, always state as fully as possible the intended service and requirements.



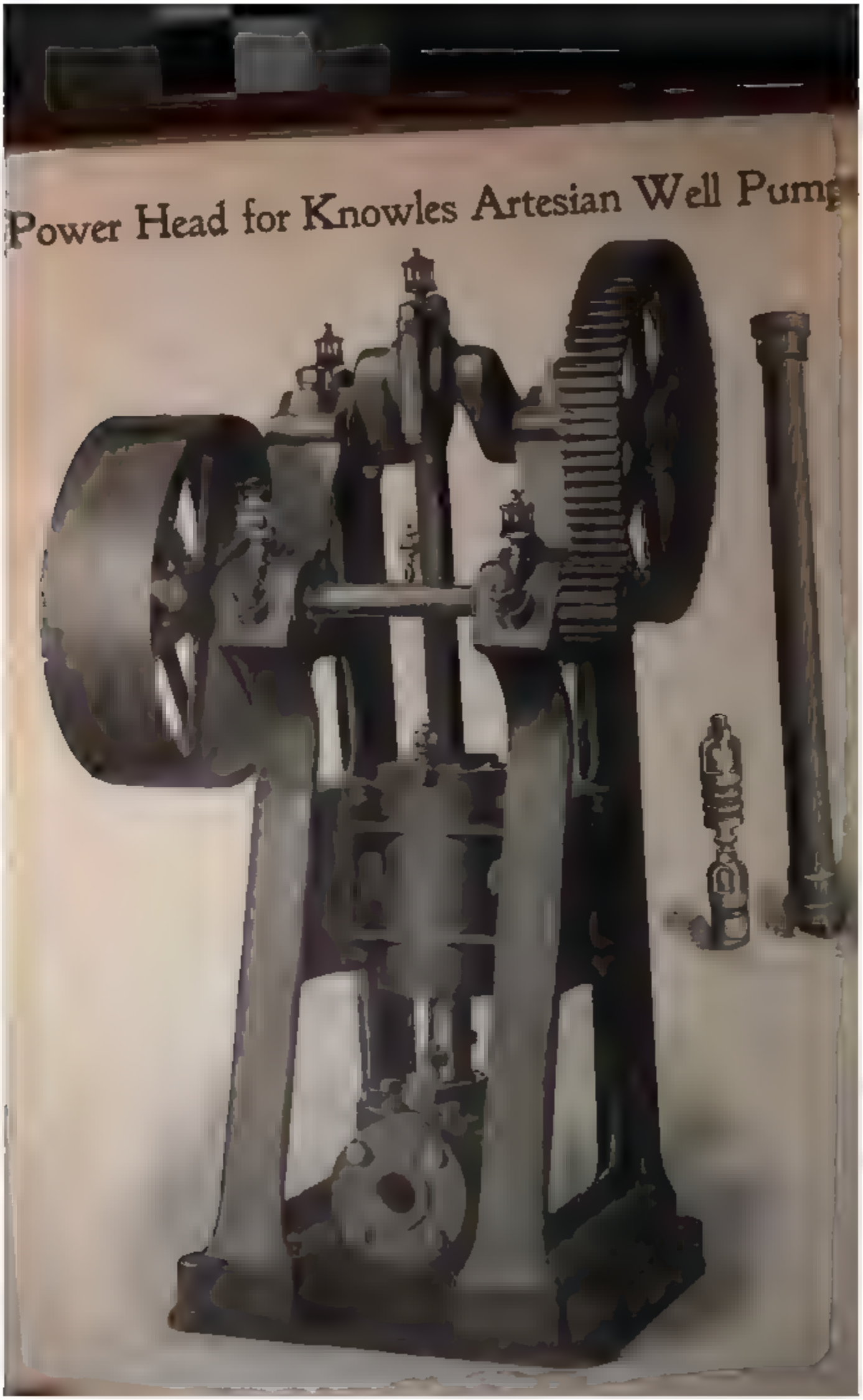
Triplex Belt-Driven Power Working Head For Operating Deep Well Single-Acting Bucket Pumps 300 ft. Lift.



Triplex Electric Working Head For Operating Deep Well Single-Acting Bucket Pumps. 300 ft. Lift.

Diameter of Buckets.	Stroke.	Revolutions per Minute.	Gallons per Revolution.	Gallons per Minute.	Suction.	Discharge	Pulleys Tight and Loose. Diam	Pulleys Tight and Loose. Face	Ratio of Pump Gears.	Ratio of Motor Gears.	H. P. Motor Required	Dimensions Over All. Power Head Not Arranged for Motor. A	B	C	Dimensions Over All. Power Head Arranged for Motor. A	B	C	Telegraphic Code Word. Belted Pumps Not Arranged for Motor.	Telegraphic Code Word. Electric Pumps, Geared. Arranged for Motor
5	8		2.04	81.60	3	3	30	5	5 to 1	To Suit Speed of Motor.	10	4' 0"	3' 6"	4' 1"	4' 5"	3' 10"	7' 2"	Mahaica	Mahlart
5½			3.448	137.92	4		30	6	5 to 1		15	5' 0"	4' 0"	5' 4"	5' 5"	4' 4"	8' 10"	Mahakala	Mahlbauk
			3.984	159.44	4		30	6	5 to 1		20	5' 0"	4' 0"	5' 4"	5' 5"	4' 4"	9' 2"	Mahaleb	Mahlgauges
			5.222	208.88	5	4	36	6	5 to 1		20	5' 3"	4' 3"	5' 11"	5' 8"	5' 0"	9' 6"	Mahamouni	Mahlgastes
	10		6.525	261.	5		42	6	5 to 1		25	6' 1"	5' 0"	6' 4"	6' 5"	5' 4"	10' 6"	Mahanaim	Mahlgelder
	10		8.262	330.	5	5	42	8	5 to 1		35	6' 8"	5' 0"	6' 4"	7' 3"	5' 6"	11' 3"	Mahanama	Mahljahr
	12	40	12.243	490.	6	7	42	8	6 to 1		50	8' 0"	6' 9"	6' 9"	8' 0"	9' 0"	6'10"	Maharajah	Mahlknecht
							One Pulley												
	12	40	37.628	705.	10	8	48	10	6 to 1		75	8' 6"	7' 6"	7' 0"	8' 6"	9' 9"	7' 4"	Maharam	Mahlohn

* The electric type has motor placed back of pump.

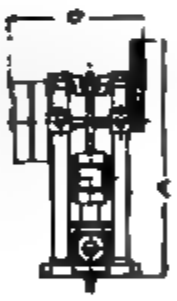

Power Head for Knowles Artesian Well Pump

Knowles "Artesian" Well Pumps.

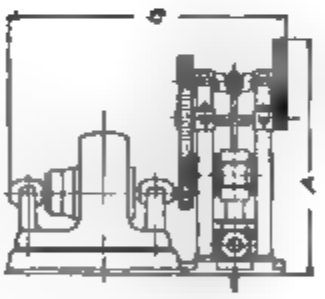
Bucket-Plunger Pattern.

Single-Acting.

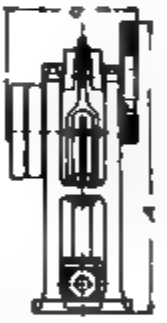
THE illustration on opposite page represents power working head for operating "artesian" well pumps. The apparatus consists of a power working head located on the surface with pipe and rod connections joining same to the artesian pump end at the bottom of the well. The pump may be driven from a water-wheel or steam engine, by belting from line shaft, or by electric motor, either belted or with reduction gears. The differential plunger causes the water to flow from the well in a continuous stream, equalizing the flow and insuring smooth running. The crank shaft is in one piece, working in ample babbitted bearings adjustable for wear. The connecting rods are steel, having adjustable babbitted box on crank end, other end being solid with brass bushing or forked end, according to power head used. The artesian pump ends are made two different ways. The working barrel or cylinder is either seamless drawn-brass tubing with cast brass top and bottom attachment, threaded for standard wrought-iron pipe connection, or inserted joint casing, or special tubing, as called for; or the cylinder is made of very hard special cast brass. The bucket and foot valve can be fitted with composition ball valve, hard rubber ball valve, or special composition disk valve, and packed with cup leather, fibrous or metallic packing. They can be easily put in place or removed for examination or repairs, through the connecting pipe, which is of larger diameter than the bore of the cylinder. Wood sucker rods with forged couplings for connecting bucket and upper plunger are furnished when specially ordered, or wrought-iron piping can be used to connect the two. Belted pumps are furnished with tight and loose pulleys. For the electric type, the extended bed-plate is specially designed to receive the specified type and size of motor. In sending inquiries or orders, always state as fully as possible the intended service and requirements.



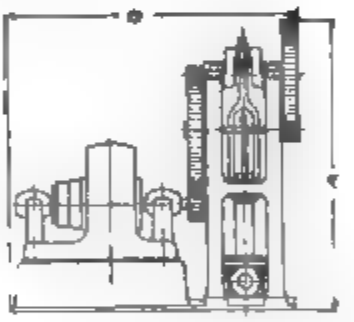
Belted, 12", 12" and 16" Stroke.



Electric, 10", 12" and 16" Stroke.



Belted, 10" and 24" Stroke.



Electric, 10" and 24" Stroke.

DIFFERENTIAL POWER WORKING HEADS FOR OPERATING SINGLE-ACTING "ARTESIAN" WELL PUMPS

Stroke	Revolutions per Min.	H P. Motor Required.	Ratio of Pump Gears	Pulleys, Tight and Loose. Diam.	Pulleys, Tight and Loose. Face.	Dimensions Over All, Power Head Not Arranged for Motor A	Dimensions Over All, Power Head Not Arranged for Motor B	Dimensions Over All, Power Head Not Arranged for Motor C	Dimensions Over All, Power Head Arranged for Motor Geared A	Dimensions Over All, Power Head Arranged for Motor Geared B	Dimensions Over All, Power Head Arranged for Motor Geared C	Telegraphic Code Word: Power Head Not Arranged For Motor.	Telegraphic Code Word: Power Head Arranged for Motor, Geared
10	45	4 - 5	10 to 1	20	4	4' 9"	2' 6"	2' 6"	4' 9"	3' 0"	4' 6"	Mahlwerk	Mahnruf
12	45	7½ - 5	10 to 1	30	5	5' 6"	3' 2"	2' 10"	5' 6"	3' 2"	5' 0"	Mahlwerken	Mahnrufes
16	30	7½ - 5	10 to 1	30	6	7' 0"	4' 2"	3' 4"	7' 0"	4' 2"	6' 0"	Mahlzahnes	Mahnst
24	25	12 - 5	10 to 1	35	6	9' 6"	5' 0"	4' 0"	9' 6"	6' 6"	7' 6"	Mahlzeiten	Mahnwort

For "Working Barrels," etc., see next page.

king Barrels. Adapted for use with Power Working Heads. Single-Acting "Artesian" Well Pumps.

Diameter of Bucket.	Diameter of Upper Plunger	Stroke.	Max. Vertical Head From Surface of Water to Point of Delivery	Revolutions per Minute	Gallons per Minute.	Discharge at Power Head.	Inside Diameter of Pipe or Casing Required.	Extreme Outside Diameter of Attachment	Size of Wood Sucker Rod Required.	Bottom of Plunger and Top of Bucket Fitted for Pipe	Telegraphic Code Word. For working barrel complete with bucket and foot valve
2¾	1⅝	10	275	40	10 28	1½"	3	3⅞	1⅝" or 1⅝"	¾"	Mahompa
		12	500	40	12. 34		3	3⅞			Mahonese
		16	500	30	12 34		3	3⅞			Mahonnais
		24	500	25	15 42		3	3⅞			Mahound
3¼	2⅜	10	200	40	14 37	2"	3½	4⅝	1½" or 1⅝"	1"	Mahout
		12	450	40	17 24		3½	4⅝			Mahovea
		16	430	30	17 24		3½	4⅝			Mahratta
		24	450	25	21 56		3½	4⅝			Mahudel
3½	2½	10	150	40	16.32	2"	4	5⅛	1½", 1⅝" or 2¼"	1" or 1¾"	Mahuiga
		12	400	40	22 94		4	5⅛			Mahuree
		16	400	30	22.94		4	5⅛			Maiadin
		24	400	25	28 67		4	5⅛			Maiahno
4¼	3	10	120	40	24 95	2½"	4½	5¼	2⅛"	1⅝"	Maianeas
		12	350	40	29 47		4½	5¼	2⅛"	1⅝"	Maiantheme
		16	350	30	29 47		4½	5¼	2⅛"	1⅝"	Maiapfel
		24	350	25	44 20		4½	5¼	2⅛"	1⅝"	Maiblaum
4¾		10	90	40	30 63	3"	5	6	2¼"	1¾"	Maiblume
		12	300	40	37 81		5	6	2¼"	1¾"	Maiblume
		16	300	30	37 81		5	6	2¼"	1¾"	Maiblume
		24	300	25	47 26		5	6	2¼"	1¾"	Maiblume
5		10	75	40	41	3½"	6	7⅛	2¼"	1¾"	Maidpale
		12	250	40	53		6	7⅛	2¼"	1¾"	Maie baum
		16	250	30	53		6	7⅛	2¼"	1¾"	Maienkranz
		24	250	25	66		6	7⅛	2¼"	1¾"	Maienkrug
5¼	4	10	70	40	43	3"	6	7⅛	3⅛"	1½"	Maienlamm
		12	200	40	53		6	7⅛	3½"	1½"	Maienlust
		16	200	30	53		6	7⅛	3½"	1½"	Maienne
		24	200	25	66		6	7⅛	3½"	1½"	Maienpfahl
6¼	4½	10	100	40	64	4"	7	8⅛	3½"	2"	Maienrose
		12	150	40	74		7	8⅛	3½"	2"	Maiensaess
		16	150	30	74		7	8⅛	3½"	2"	Muenstock
		24	150	25	92		7	8⅛	3½"	2"	Maienthal
7¼	5¼	12	110	40	95 24	4"	8	9⅛	3½"	2"	Maienzeit
		16	110	30	95 25		8	9⅛	3½"	2"	Maiero
		24	110	25	119		8	9⅛	3½"	2"	Maieutical
8½	6	12	90	40	115 32	5"	9	10⅝	3½"	2"	Maieutique
		16	90	30	115 32		9	10⅝	3½"	2"	Maieuze
		24	90	25	147 90		9	10⅝	3½"	2"	Maifliege

Directions for Placing and Operating the Power Working Head, Etc., for the "Artesian" Well Pumps.

TO assemble the parts at well, bolt the bed plate to timbering or masonry at the surface, the pump cylinder is screwed to the connecting pipe and lowered into the well through the bed-plate by special wrought-iron clamps to fit the pipe which will be furnished at slight extra charge if desired. The discharge piece is screwed to the connecting pipe and then bolted to the bed-plate, the foot valve if used, bucket and sucker rod are next lowered into place The differential plunger is attached to the sucker rod at the upper end of the working head The stuffing-box is slipped over plunger and bolted to discharge pipe. The main frame carrying the pulleys, etc, is then bolted to bed-plate the differential plunger is attached to the connecting rod and the working head is ready for operation When the rods, plunger or lower valve require attention, these parts can be drawn out after removing the frame and the stuffing-box of the working head without disturbing the bed-plate or disconnecting the pipes, depending upon the style of working head that is selected for the work We will furnish when specially ordered, and at extra price, sprocket wheels for link belt, grooved pulleys for wire rope, or manilla rope, to suit motive power.

Sucker Rods.

Wood or Wrought-Iron Pipe.

Diamater of Bucket.	Size of Wood Sucker Rod.	Size of Gas-Pipe Sucker Rod.
$2\frac{1}{4}$″	$1\frac{1}{2}$″ or $1\frac{5}{8}$″	$\frac{3}{4}$″ or 1″
$3\frac{1}{4}$″	$1\frac{1}{2}$″, $1\frac{5}{8}$″ or $2\frac{1}{4}$″	1″ or $1\frac{1}{4}$″
$5\frac{1}{4}$″	$3\frac{1}{2}$″	$1\frac{1}{2}$″
$6\frac{1}{4}$″	$3\frac{1}{2}$″	2″
$9\frac{1}{4}$″	4″	$2\frac{1}{2}$″

When wood sucker rods are used to connect plunger and bucket, a forged wrought-iron connection is used on bottom of plunger and top of bucket, made to suit sucker-rod coupling.

We advise for small buckets the use of double extra-strong wrought-iron pipe for sucker rods, which restricts the flow of water very little where it enters the cylinder, as the cross-section is much less than the wood sucker rod.

On the bottom of the artesian well cylinders can be attached strainers made of wrought-iron, perforated, or gauze-wire strainers, furnished at extra price.

The working heads are also arranged to drive two or three pumps, forming duplex or triplex pumps, and used for water supply of towns, villages, and for manufacturing purposes.

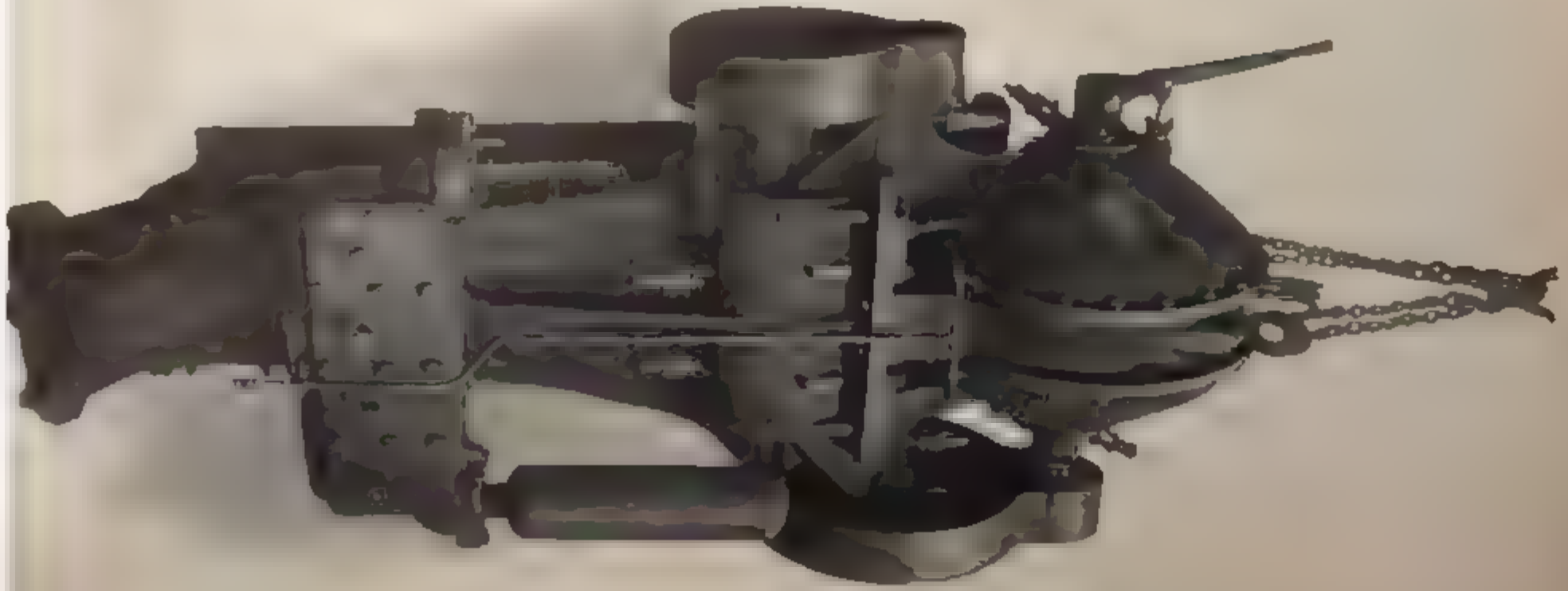
We solicit correspondence for further details.

MEMORANDUM.

5″	Well will take	3″	Pipe and	$2\frac{1}{4}$″	Bucket, or	$3\frac{1}{2}$″	Flush Joint	Pipe, and	$3\frac{1}{4}$″	Bucket.							
$5\frac{1}{2}$″	"	"	$3\frac{1}{2}$″	"	"	$3\frac{1}{4}$″	"	"	4″	"	"	"	"	$3\frac{1}{4}$″	"		
6″	"	"	4″	"	"	$3\frac{1}{4}$″	"	"	$4\frac{1}{2}$″	"	"	"	"	$4\frac{1}{4}$″	"		
$6\frac{1}{2}$″	"	"	$4\frac{1}{2}$″	"	"	$4\frac{1}{4}$″	"	"	5″	"	"	"	"	$4\frac{1}{4}$″	"		
7″	"	"	5″	"	"	$4\frac{1}{4}$″	"	"	6″	"	"	"	"	$5\frac{1}{4}$″	"		
8″	"	"	6″	"	"	$5\frac{1}{4}$″	"	"	7″	"	"	"	"	$6\frac{1}{4}$″	"		
9″	"	"	7″	"	"	$6\frac{1}{4}$″	"	"	8″	"	"	"	"	7″	"		
10″	"	"	8″	"	"	7″	"	"	9″	"	"	"	"	$8\frac{1}{2}$″	"		
12″	"	"	9″	"	"	$8\frac{1}{2}$″	"	"	10″	"	"	"	"	$9\frac{1}{2}$″	"		

"Flush Joint" pipe is regular standard wrought-iron pipe, without the usual couplings. It has one end of each length bored and tapped; the other end is turned-off and threaded. Where it is possible, always use regular standard pipe in preference to "Flush Joint" pipe or well casing. It is well to bear in mind that the pumping capacity of a non-flowing "Artesian" well depends upon the size of its bore. The diameter of the well limits the size of the piping (at the end of which the pump barrel is screwed), and the diameter of this piping limits the size of the pump bucket; hence only a certain amount of water can be got out of a well of designated bore. The above is on the supposition that the well is straight and of uniform bore, and that pipe is straight when screwed together.

Knowles Vertical Duplex Electric Sinking Pump.



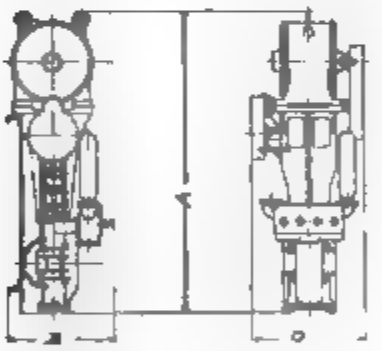
Double-Acting Plunger Pattern.

Size, 6 x 6.

Knowles Vertical Duplex Electric Sinking Pumps.

Double-Acting Plunger Pattern.

IE cut shown on opposite page represents a mine pump which has given entire satisfaction in every case. This pump is light in weight, compact in form, very efficient, and of good capacity, and is not liable to damage from moisture or hard usage. The motor with its ng and operating mechanism is enclosed in a tight casing, the only moving parts visible g short sections of the plungers and rods, but every part of motor and pump is readily accessi- for examination or repairs, and can be quickly and easily replaced. This apparatus is gned to stand more hard usage without injury than any type of sinking pump in the market ld a sudden inrush of water in the mine completely drown the pump, it will continue to work out being affected in the least, if provided with an "Iron Clad" motor such as made he General Electric Company. The motor casing being tight, the pump will work as well er water as out; in fact the cooling action of the water is rather an advantage than otherwise. per insulation of cables is of course absolutely essential. There are no exposed working parts e to damage, or to cause injury to those who may be working about the pump. Connecting are of steel, having babbitted box on crank end, other end being solid with brass bushing. Gears are machine cut. The main frame is designed especially to receive the specified type ize of motor. As the plungers and piston rods are packed from the outside, any leakage is ily noticeable. Each pump is furnished with a discharge air chamber. All material is of the test grade and great care is taken in the test to prove there is no defect. In sending inquiries rders, always state as fully as possible the intended service and requirements.

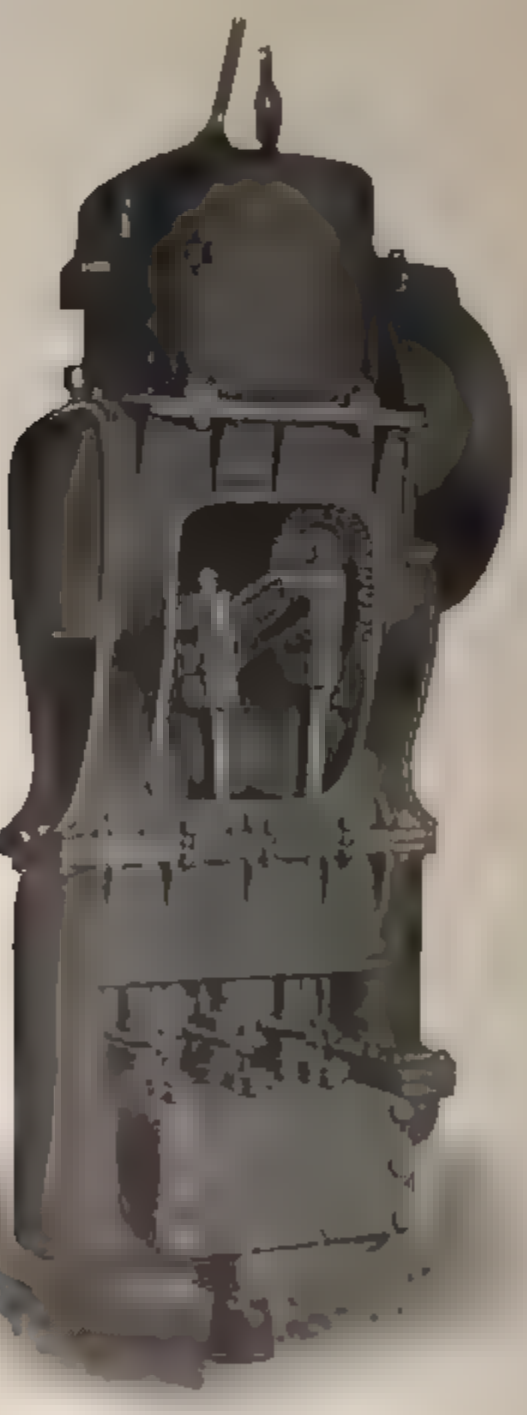


Vertical Duplex Electric Sinking Pumps.
Double-Acting Plunger Pattern.

Stroke	Vertical Head in Feet.	Revolutions Per Minute.	Gallons per Revolution	Gallons per Minute.	Suction.	Discharge	Ratio of Pump Gears.	Ratio of Motor Gears	H. P. Motor Required	Dimensions Over All A	Dimensions Over All B	Dimensions Over All C	Telegraphic Code Word.
6	400	55	.734	40.37	3	2	3.5 to 1	To Suit Speed of Motor	10	8' 8"	3' 0"	2' 9"	Makreelen
6	300	55	1.305	104.40	4	3	2.7 to 1		7½	8' 8"	3' 0"	2' 9"	Makrizi
6	500	80	1.305	104.40	4	3	3.7 to 1		20	9' 4"	3' 8"	3' 6"	Maktesh
6	300	75	2.04	153.00	5	4	3.7 to 1		20	10' 2"	3' 8"	4' 2"	Malabaria
6	400	80	2.04	163.20	5	4	3.7 to 1		30	10' 4"	3' 8"	4' 2"	Malabare
5	200	86	2.937	252.58	6	5	3.7 to 1		20	10' 4"	3' 6"	4' 2"	Malabathri
5	250	86	2.937	252.58	6	5	3.7 to 1		25	10' 4"	3' 9"	4' 2"	Malabatro
5	400	62	3.916	242.79	6	5	3.5 to 1		50	11' 2"	4' 6"	4' 10"	Malabbiato
5	300	70	4.592	321.44	6	5	3.5 to 1		50	11' 2"	4' 6"	4' 10"	Malabranca
5	300	68	5.328	362.30	8	6	3.5 to 1		50	11' 2"	4' 6"	4' 10"	Malacalite
5	300	58	6.960	403.68	8	6	3.5 to 1		50	11' 2"	4' 6"	4' 10"	Malacasma

Knowles
Vertical Triplex Electric Sinking Pump

Single-Acting Plunger Pattern.



Size, 6½ x 8

Knowles Vertical Triplex Electric Sinking Pumps.

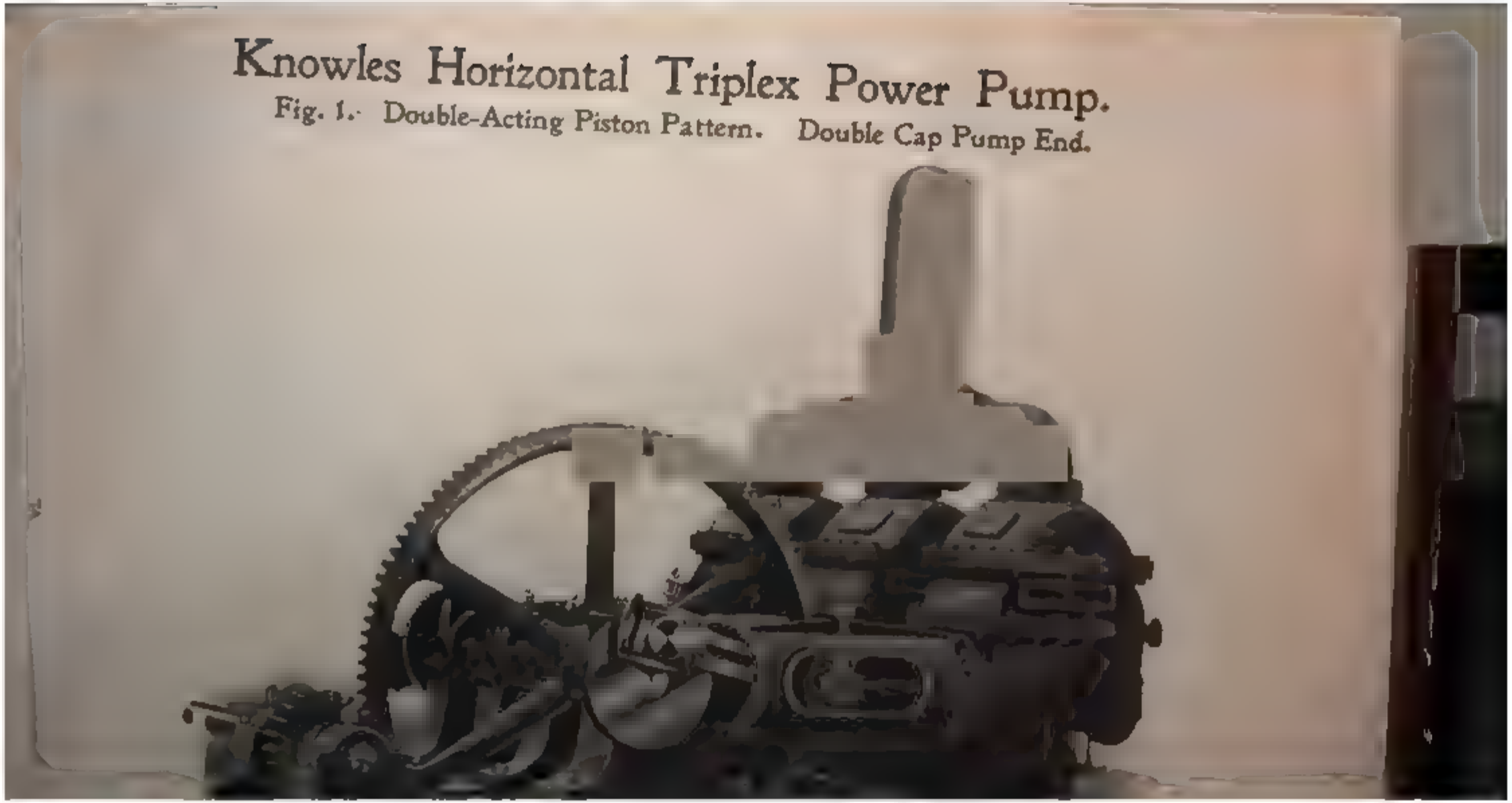
Single-Acting.

ON pages 70 and 71 we have described our Duplex Electric Sinking Pumps. In addition to these we build Triplex Electric Sinking Pumps of the type shown by cut on opposite page. This type, as well as the duplex, may be operated by an electric current generated miles away from the point of application. With electric current no heating effect is produced in the shaft, the steam pipe being entirely eliminated. There is no waste of current, as, when the pump is in use, the current is consumed in exact proportion to the work performed. The lower part of pump is one casting, so constructed as to form the water cylinders, guides, and suction and discharge air chambers. These chambers insure a smoother running pump, removing all shock and jar from the column pipe. The connecting rods, crank shaft and gear may be seen through opening in upper part of pump. This opening is provided with a cover, so that the running gear is entirely enclosed and protected from stones, dirt, etc., the only visible moving parts being short sections of the plungers. Two gears which, to economize space, are fitted over the disks which form the outside cheeks of the end cranks, serve to drive the steel crank shaft. The first two sizes in table, however, are of a somewhat different design. The general construction in regard to connecting rods, material and workmanship, frame to suit motor, etc., are the same as for the duplex electric sinking pumps.

Diameter of Plungers.	Stroke.	Vertical Head in Feet.	Revolutions Per Minute.	Gallons per Revolution.	Gallons per Minute	Suction.	Discharge.	Ratio of Pump Gears	Ratio of Motor Gears. To Suit Speed of Motor	H. P. Motor Required	Dimensions Over All. Height	Width	Depth	Telegraphic Code Word.
3½	4	200	56	.3672	20.56	1¼	1½	5 to 1		2	5'	8"	2' 5"	2' 5"	Maiuna
3½	4	300	62	.3862	51.22	2½	2½	4 to 1		5	5'	8"	2' 9"	2' 5"	Matusculo
3½	4	350	65	.9792	63.64	3	3	4 to 1		10	7'	6"	3' 0"	2' 10"	Maivogel
3½	4	350	65	1.53	99.45	3	3	4 to 1		15	7'	9"	3' 6"	2' 10"	Maiwurm
3½	4	350	65	2.04	132.60	5	4	4 to 1		20	10'	0"	3' 3"	3' 2"	Maiwurmes
3½	4	350	65	2.468	160.42	5	4	4 to 1		25	10'	0"	3' 3"	3' 2"	Maizales
3½	4	350	60	3.446	206.76	5	4	4 to 1		30	10'	11"	3' 9"	3' 6"	Maizena
3½	4	350	60	5.223	313.32	6	5	4 to 1		50	11'	2"	4' 4"	4' 0"	Maizinha

Knowles Horizontal Triplex Power Pump.

Fig. 1.- Double-Acting Piston Pattern. Double Cap Pump End.



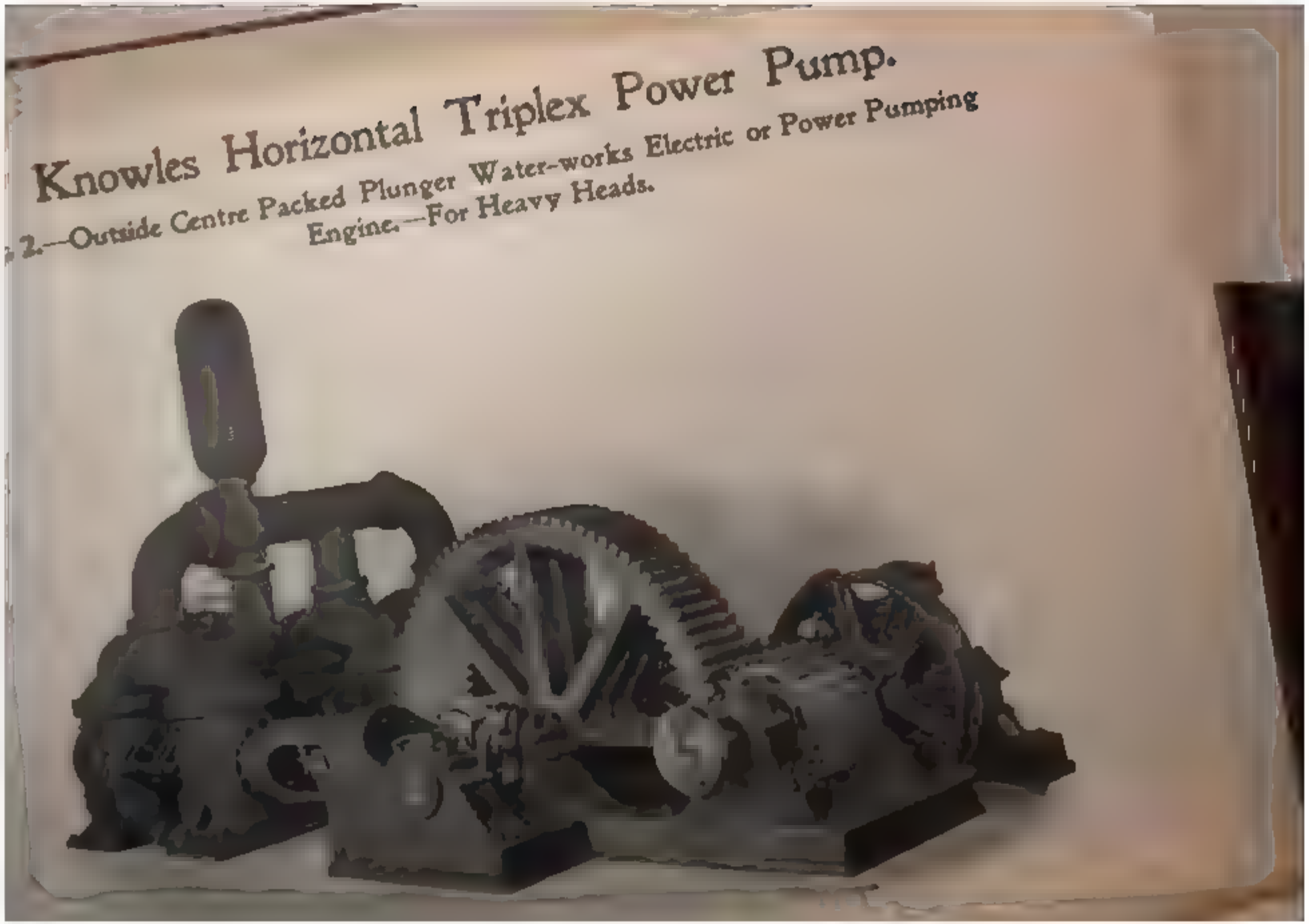
Knowles Horizontal Triplex Power Pumps.

Double-Acting Piston Pattern.

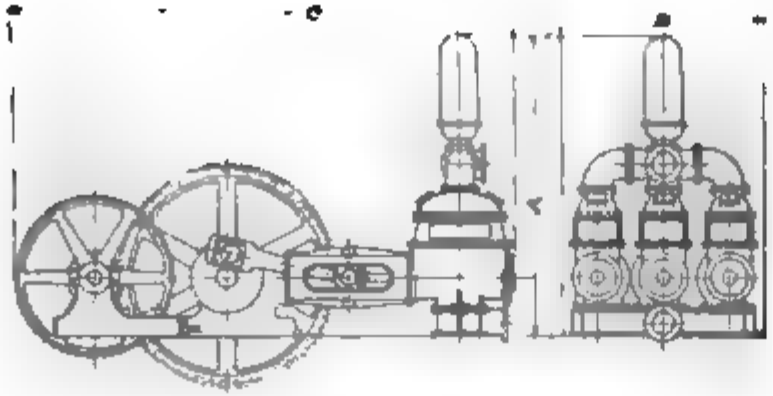
THE accompanying cut (Fig. 1) represents our latest type of horizontal triplex pump of the double-acting piston pattern. This type can be geared directly to the jack-shaft of a turbine or water-wheel, belted from motor, or direct connected to same by gears, or it may be belted from any convenient line shafting. The pump end is of the "double-cap" type and may be fitted with composition valve-plates between cylinder and caps when salt water is used. All valves are accessible through ample handholes conveniently located. The support for cylinders forms the suction chamber for pump. The main bearings, which are adjustable for wear, are located in pedestals having centrepieces attached provided with slides for crossheads. This design makes a well-proportioned and rigid machine. All parts subjected to wear are provided with adjustment. Among the features of this type may be enumerated the cast-iron cut gears, the steel connecting rods with babbitted boxes on crank ends, the accessibility of parts for adjustment and repairs, and the high quality of workmanship and material. The sizes in upper part of table are suitable for 300 feet lift, those below for 100 feet lift. When sending inquiries or orders, always state as fully as possible the intended service and requirements. The cut (Fig. 2, page 76) represents our triplex, outside, centre-packed plunger type, electric or power driven, used for heavy heads on water-works service, of which we will be pleased to give further details upon request.

Knowles Horizontal Triplex Power Pump.

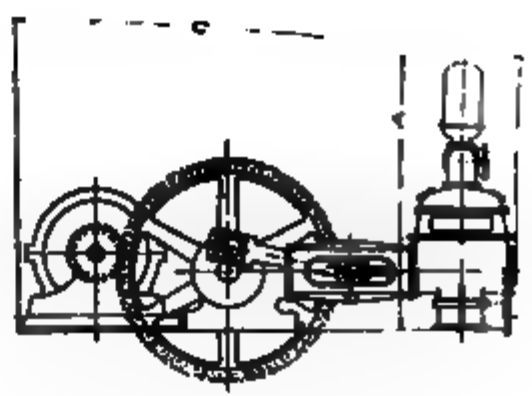
No. 2.—Outside Centre Packed Plunger Water-works Electric or Power Pumping Engine.—For Heavy Heads.



Double-Acting Piston Pattern.



Horizontal Triplex Power Pumps.
Belt Driven—Double-Acting Piston Pattern.



Horizontal Triplex Electric Pumps.
Double-Acting Piston Pattern.

FOR 300 FEET LIFT.

Diameter of Pistons	Stroke.	Revolutions per Minute.	Gallons per Revolution	Gallons per Minute	Suction.	Discharge	*Pulleys Tight and Loose Diam.	*Pulleys Tight and Loose Face	Ratio of Pump Gears.	Ratio of Motor Gears To Suit Speed of Motor	H. P. Motor Required.	Dimensions Over All Belted Pumps Not Arranged for Motor A	Dimensions Over All Belted Pumps Not Arranged for Motor B	Dimensions Over All Belted Pumps Not Arranged for Motor C	Dimensions Over All, Arranged for Motor, Geared. A	Dimensions Over All, Arranged for Motor, Geared. B	Dimensions Over All, Arranged for Motor, Geared. C	Telegraphic Code Words. Belted Pumps Not Arranged for Motor.	Telegraphic Code Words. Electric Pumps Geared Arranged for Motor
8	12	50	6.81	441	8	6	42	6	4 to 1		55	10′ 0″	6′ 6″	22′ 0	10′ 0″	6′ 8″	19′ 10″	Malfaire	Malpolitus
10	12	50	15.66	783	10	8	48	8	4 to 1		85	10′ 6″	7′ 4″	21′ 10″	10′ 6″	7′ 6″	20′ 2″	Malfatto	Malia [illegible]
10	12	50	24.48	1224	12	10	108	10	4 to 1		130	11′ 2″	8′ 6″	22′ 4″	11′ 2″	8′ 5″	20′ 8″	Malfazejo	Malpolo
12	12	50	35.25	1763	14	12	144	12	4 to 1		220	11′ 8″	9′ 10″	23′ 10″	11′ 8″	10′ 4″	21′ 10″	Malfettor	Malic [illegible]
12	12	35	52.87	1850	14	12	144	12	4 to 1		230	11′ 8″	10′ 2″	25′ 11″	11′ 8″	10′ 8″	23′ 11″	Malfelice	Malpolado
14	12	50	47.96	2398	16	14	144	12	4 to 1		300	12′ 4″	11′ 0″	25′ 10″	12′ 4″	11′ 8″	21′ 8″	Malfend	Malpolo
14	18	35	71.91	2515	16	14	168	12	4 to 1		320	12′ 4″	11′ 2″	26′ 7″	12′ 4″	11′ 10″	21′ 5″	Malferido	Malpolino
16	12	50	62.64	3132	18	16	168	12	4 to 1		450	13′ 0″	12′ 0″	25′ 6″	13′ 0″	12′ 8″	22′ 8″	Malfondato	Malpolosa
16	18	35	93.96	3289	18	16	168	12	4 to 1		470	13′ 0″	12′ 3″	26′ 7″	13′ 0″	13′ 4″	23′ 7″	Malfrat	Malpolox

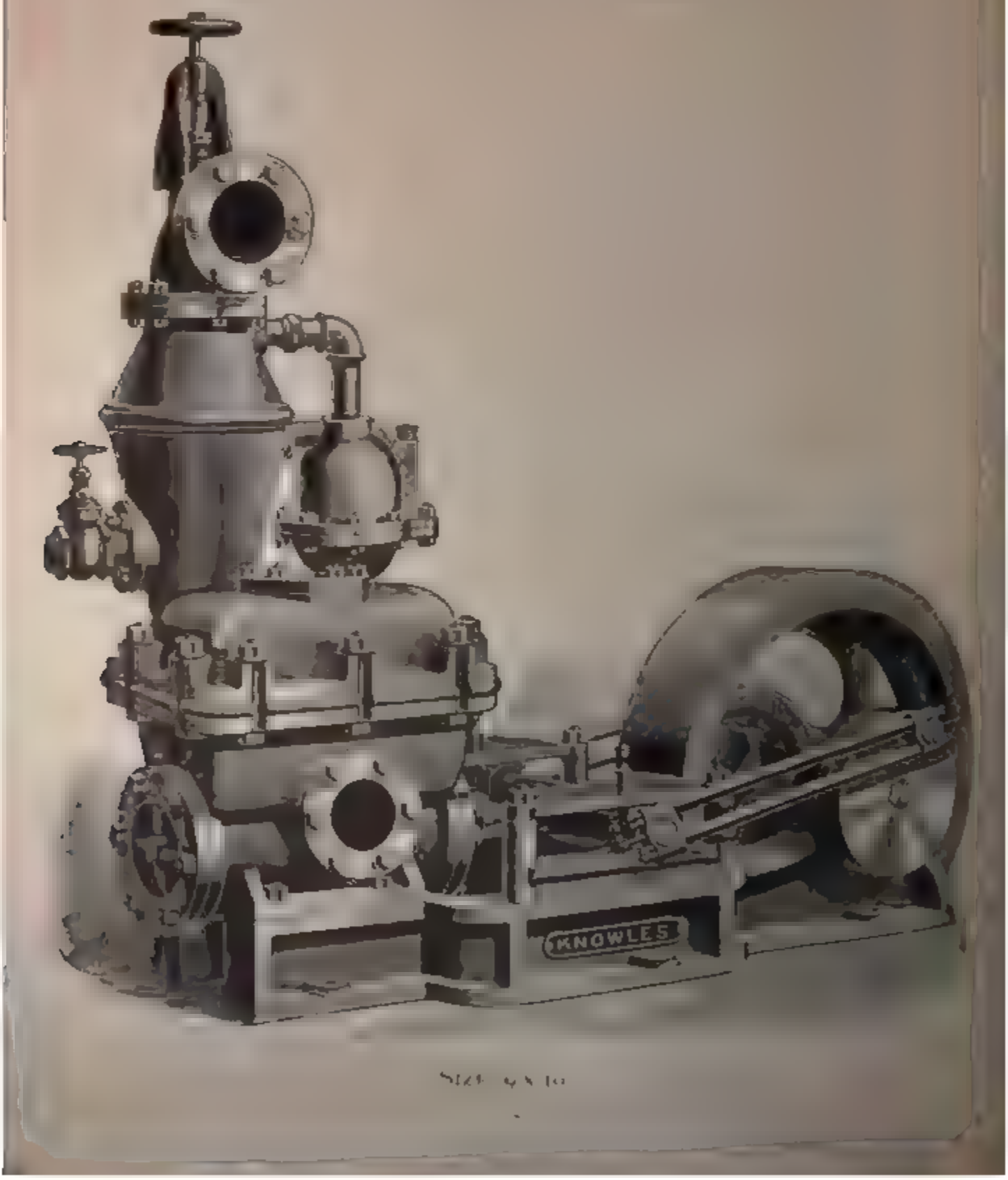
SIZES BELOW ARE FOR 100 FEET LIFT.

8	12	50	6.81	441	8	6	42	6	4 to 1		22	10′ 0″	6′ 6″	18′ 2″	10′ 0″	6′ 2″	18′ 0″	Malgache	Malpolitan
10	12	50	15.66	783	10	8	48	8	4 to 1		35	10′ 6″	6′ 10″	18′ 8″	10′ 6″	7′ 0″	18′ 4″	Malgalante	Malpolous
10	12	50	24.48	1224	12	10	96	8	4 to 1		50	11′ 2″	7′ 8″	19′ 4″	11′ 2″	8′ 0″	18′ 11″	Malgasteis	Malpolo [illegible]
12	12	50	35.25	1763	14	12	120	8	4 to 1		75	11′ 8″	9′ 0″	21′ 4″	11′ 8″	9′ 8″	20′ 6″	Malgasto	Malpolo [illegible]
12	18	35	51.87	1850	14	12	96	8	4 to 1		80	11′ 8″	9′ 2″	22′ 8″	11′ 8″	9′ 10″	21′ 11″	Malgoverno	Malpolonia
14	12	50	47.96	2398	16	14	96	8	4 to 1		100	12′ 4″	10′ 4″	22′ 0″	12′ 4″	10′ 1″	20′ 2″	Malgradito	Malpolopo
14	18	35	71.91	2515	16	14	108	12	4 to 1		110	12′ 4″	10′ 6″	23′ 8″	12′ 4″	10′ 8″	21′ 6″	Malgre	Malpolos
16	12	50	62.64	3132	18	16	108	10	4 to 1		120	13′ 0″	11′ 4″	23′ 0″	13′ 0″	11′ 10″	20′ 2″	Malhabille	Malpolosum
16	18	35	93.96	3289	18	16	144	12	4 to 1		150	13′ 0″	11′ 7″	24′ 8″	13′ 0″	12′ 1″	21′ 8″	Malhada	Malpot

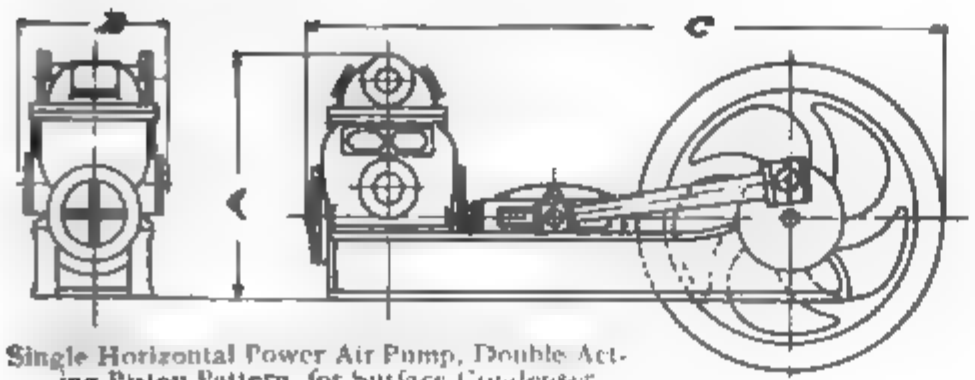
*Tight and loose pulleys are furnished up to 12-inch face, inclusive. Over 12-inch face, tight pulley only is furnished.

Knowles Single Horizontal Power Air Pump and Jet Condenser.

Belted Pump. Double-Acting Piston Pattern.

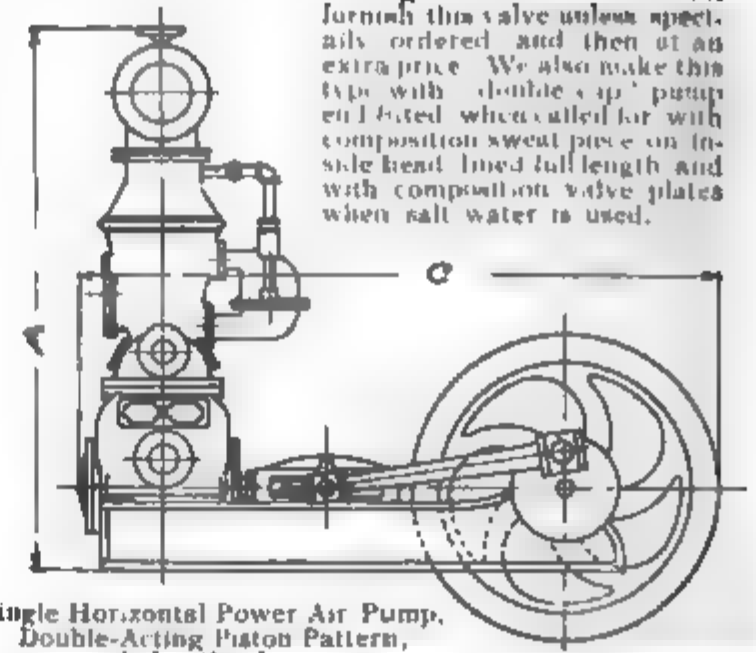


...by gearing direct from motor, but we advise our triplex type for this. The engraving opposite represents a compact, strong and well-built machine having no complicated mechanism and but few wearing parts. It is fitted with a jet condenser of the latest improved design having an adjustable cone for spray, and our patent automatic "break vacuum" safety attachment, and embodies several other new and valuable features. The vacuum breaking attachment instantly secures an opening to the atmosphere, should the water rise above a safe point in condenser, and thereby stops the inflow of water. The hand-wheel on the extreme top of condenser is for adjusting the position of cone, thereby regulating the thickness of the spray inside and the amount of injection water supplied. When necessary to clean the condenser the cone can be raised enough to give a full, clear passage for the water to flush away any dirt, grass, etc., that may have collected. The pump is double-acting, having ample valve area and passages. The band



Single Horizontal Power Air Pump, Double Acting Piston Pattern, for Surface Condenser

easily applied to any non-condensing steam engine, increasing the power from 20 to 30 per cent., or, when additional power is not required, showing a corresponding saving in fuel. There should be a gate valve on the suction pipe for regulating the amount of water necessary for condensing the steam. We do not furnish this valve unless specially ordered and then at an extra price. We also make this type with "double cup" pump end fitted when called for with composition sweat piece on inside head lined full length and with composition valve plates when salt water is used.



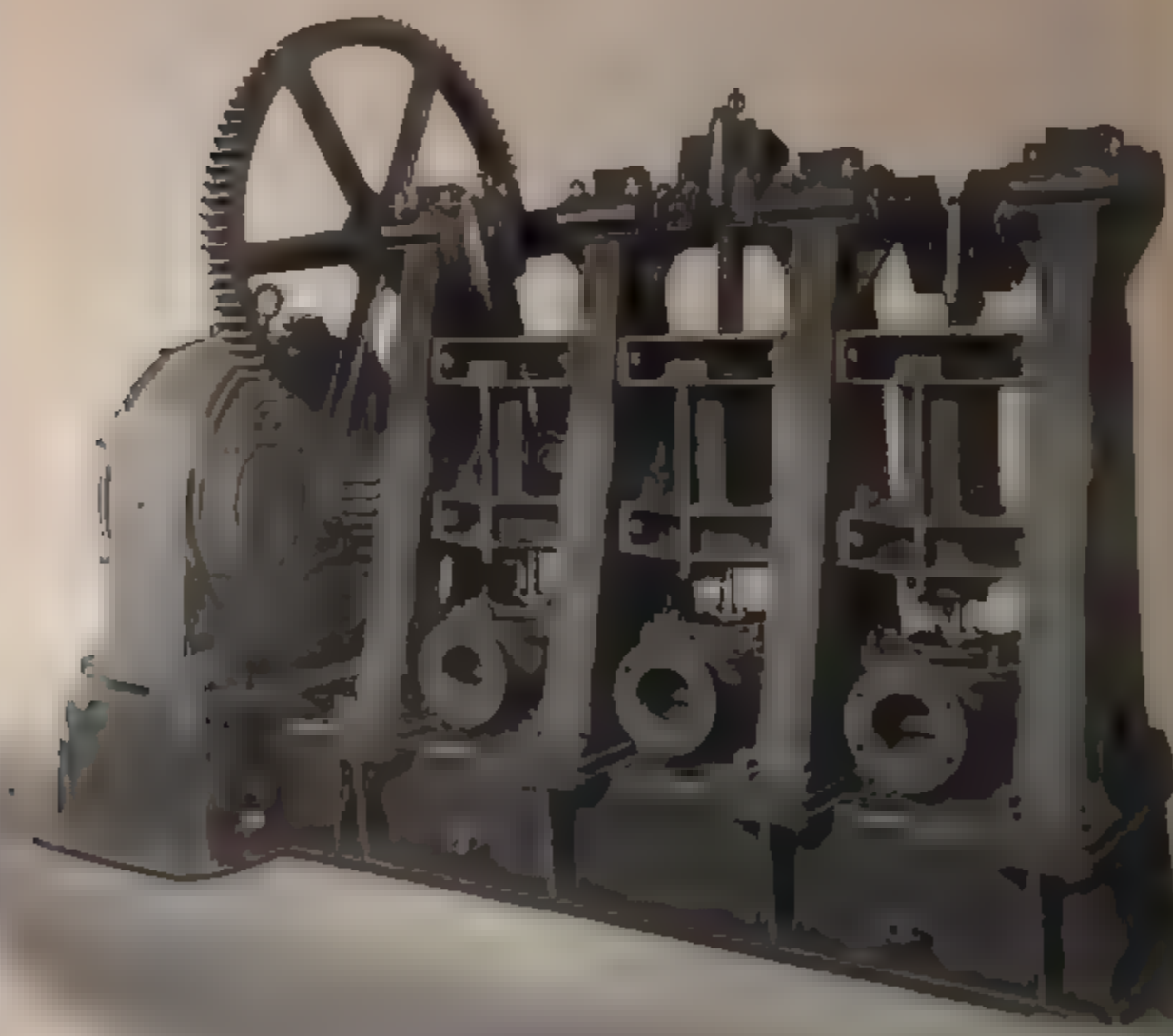
Single Horizontal Power Air Pump, Double-Acting Piston Pattern, with Jet Condenser.

Diameter of Air Cylinder.	Stroke.	Revolutions per Minute.	Pulley. Diameter.	Pulley. Face.	Surface Condensing. Suction.	Surface Condensing. Discharge	Surface Condensing. Steam per Hour, Lbs.	Jet Condensing. Discharge	Jet Condensing. Size of Condenser.	Jet Condensing. Injection.	Jet Condensing. Exhaust Opening	Jet Condensing. Steam per Hour, Lbs.*	Dimensions Over All, Surface Condensing. A	B	C	Dimensions Over All with Jet Condenser. A	B	C	Telegraphic Code Word. Arranged For Surface Condenser	With Jet Condenser
9	10	40	32	6½	5	4	5370	4	12	2	To Suit Exhaust Pipe of Engine	1710	4' 10"	2' 3"	6' 6"	6' 8"	3' 1"	6' 0"	Lexeos	Lexilogic
10	12	40	38	6½	5	4	8000	5	15	3		2670	5' 0"	2' 3"	7' 4"	7' 0"	3' 3"	7' 4"	Lexiarca	Lexiphanic
12	12	40	42	8½	5	4	11500	5	15	3		3840	5' 2"	2' 3"	7' 6"	7' 2"	3' 5"	7' 6"	Lexiarque	Lexipyretic
14	12	40	56	8½	6	5	15700	6	18	3		5250	5' 4"	2' 6"	9' 2"	8' 0"	4' 0"	9' 2"	Lexical	Lexis
14	16	30	60	10½	6	5	15700	6	21	3		5250	5' 8"	2' 10"	10' 0"	8' 0"	4' 2"	10' 0"	Lexically	Lexovien
16	16	30	78	10½	8	6	20500	8	21	3		6850	5' 10"	3' 2"	12' 3"	8' 0"	5' 0"	12' 3"	Lexicology	Lexoviorum

*The capacities of the jet system are figured with the injection water at a temperature not exceeding 70° Fahrenheit, and in case of warmer or colder water, larger or smaller sizes, respectively, should be selected.

Knowles Vertical Triplex "Suction-Valveless" Electric Air Pump.

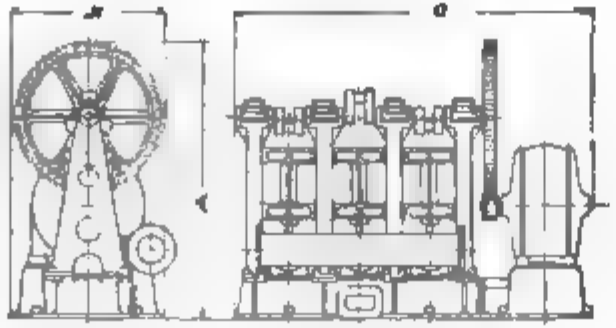
Single-Acting.



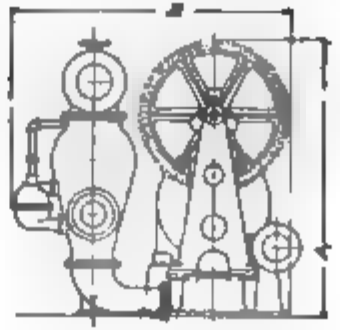
SIZE, 11 X 12

This pump is also made of the double-acting type, as described on pages 82 and 83.

THIS type of pump is an entire departure from the regulation apparatus in air-pumping machinery. The principles of its construction are novel and the theory of its action is correct, while its use in practice shows the pump to be one of the most efficient yet designed. The features of this type are in the air cylinders. Each of these is single-acting with a vertical barrel having discharge valves on a plate at its upper end. There are no suction valves, only a series of ports arranged around the lower end of barrel. The condensed steam collects in a chamber at the extreme lower end of the barrel, entering through an annular passage which extends around the barrel at a height on a line with the suction ports. The lower face of the piston is conical, and at the lowest position is below the suction ports. The clearances between the piston faces and the ends of the barrel are very small. This type may be used with a jet or surface condenser, but when with jet condenser clear water must be supplied. Owing to the construction in this type the space occupied is considerably less, particularly in height, than in other makes of machines for the same service. The number of pieces is less and access to all parts is made easier. The running parts are carefully designed for their work, have large bearing surfaces and are adjustable for wear in all parts. The gear and pinion are regularly of cast-iron, having machine-cut teeth, but we will furnish a fibre pinion for the armature shaft to reduce noise to a minimum, if specially ordered, and at extra price. The pump, together with its electric motor, is mounted on a rigid bed-plate, which also forms the suction box for the pump cylinders. The machine as a whole is designed so as to combine solidity with lightness and with a view to accessibility. It is carefully constructed of the best materials and is up-to-date in every respect.



Triplex "Suction-Valveless" Electric Air Pump, Single-Acting, for Surface Condenser.



Triplex "Suction-Valveless" Electric Air Pump, Single-Acting, with Jet Condenser.

Diameter of Air Cylinders.	Stroke	Discharge Opening	Surface Condensing. Revolutions per Minute	Steam per Hour, Lbs.	H. P. Motor Required	Revolutions per Minute, Motor	Jet Condensing. Steam per Hour, Lbs.*	H. P. Motor Required	Revolutions per Minute, Motor	Size of Condenser	Exhaust fitted	Injection	Dimensions Over All, Surface Condensing. A	B	C	Dimensions Over All with Jet Condenser. A	B	C	Telegraphic Code Word. Arranged For Surface Condenser.	With Jet Condenser.
8			100	10500	6	600	2400	5½	600	12		3	5′ 10″	3′ 5″	5′ 8″	5′ 10″	5′ 9″	5′ 10″	Lherzolite	Levcestrie
8			100	14000	8	600	3350	10	600	15		4	6′ 0″	3′ 5″	8′ 2″	6′ 0″	6′ 0″	8′ 4″	Liability	Leyeron
9			100	18000	10	600	4300	12½	600	15		4	6′ 0″	3′ 5″	8′ 10″	6′ 0″	6′ 0″	9′ 0″	Liableness	Leyesen
10			100	21600	12½	600	5150	15	600	18		5	6′ 0″	3′ 5″	9′ 4″	6′ 0″	6′ 2″	9′ 6″	Liaulis	Leyssere
10	0		100	27000	17½	600	6500	20	600	18		5	6′ 10″	3′ 10″	9′ 6″	6′ 10″	6′ 8″	9′ 9″	Liaculum	Lezardait
11	12		100	40000	25	570	9600	30	570	21		6	7′ 8″	4′ 3″	10′ 0″	7′ 8″	7′ 3″	10′ 4″	Liadouro	Lezardelle
12	12		100	48000	30	570	11500	35	570	24		7	8′ 2″	4′ 6″	10′ 8″	8′ 2″	7′ 8″	11′ 0″	Liagora	Lezen
13	12	10	100	55000	35	570	13200	40	570	24	To Suit Exhaust Pipe of Engine	7	8′ 6″	4′ 10″	11′ 8″	8′ 6″	7′ 10″	12′ 0″	Lianca	Lezenaars
14	12	10	100	66000	40	570	15800	45	570	26		8	9′ 0″	5′ 1″	12′ 8″	9′ 0″	8′ 2″	13′ 0″	Liandarum	Lezende

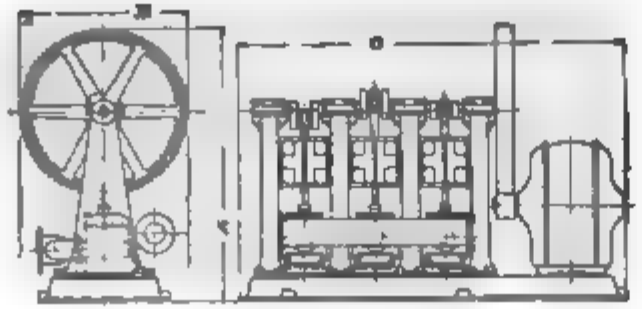
*The capacities of the jet system are figured with the injection water at a temperature not exceeding 60° Fahrenheit, and in case of warmer or colder water, larger or smaller sizes should be selected.

Knowles
Vertical Triplex "Suction-Valveless" Electric Air Pumps.
Double-Acting.

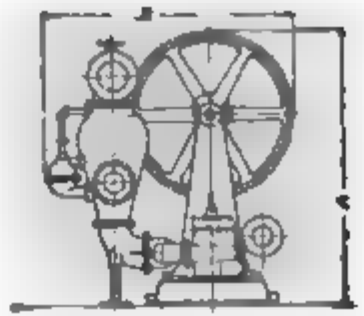
Type as per Cut on page 80, but with Double-Acting Air Cylinders.

IN this type of pump three air cylinders of the "Featherweight" pattern are combined with a running gear of proper design to be driven by an electric motor. It may be used with either a jet or a surface condenser, but when with jet condenser clear water must be supplied. The machine with its motor is mounted on a rigid bed-piece, so that the entire apparatus is compact and self-contained. The running parts are carefully proportioned to their work, having large bearing surfaces and proper adjustment for wear in all parts. This type is fitted regularly with machine cut, cast-iron gear and pinion, but to reduce noise to a minimum we will furnish, at extra price, a fibre pinion for the armature shaft. The piston travelling by the single suction port, located centrally in each cylinder, controls the supply of air and water, thus doing away with the necessity of suction valves and reducing the size and number of parts for the air end. Each cylinder is so designed that there is practically no clearance between the piston and the ends of cylinder, thereby giving a better vacuum. The discharge valves for lower end are located at the bottom of cylinder, so placed that access to them is made easy by ample handholes on one side. Those for the upper end are located in a chamber on top of the cylinder and are reached by raising the upper head. The machine as a whole is designed so as to combine solidity with lightness and with a view to accessibility. It is carefully constructed of the best materials and is up-to-date in every respect.

Knowles Vertical Triplex "Suction-Valveless" Electric Air Pumps. Double-Acting.



Triplex "Suction-Valveless" Electric Air Pumps, Double-Acting, for Surface Condenser.



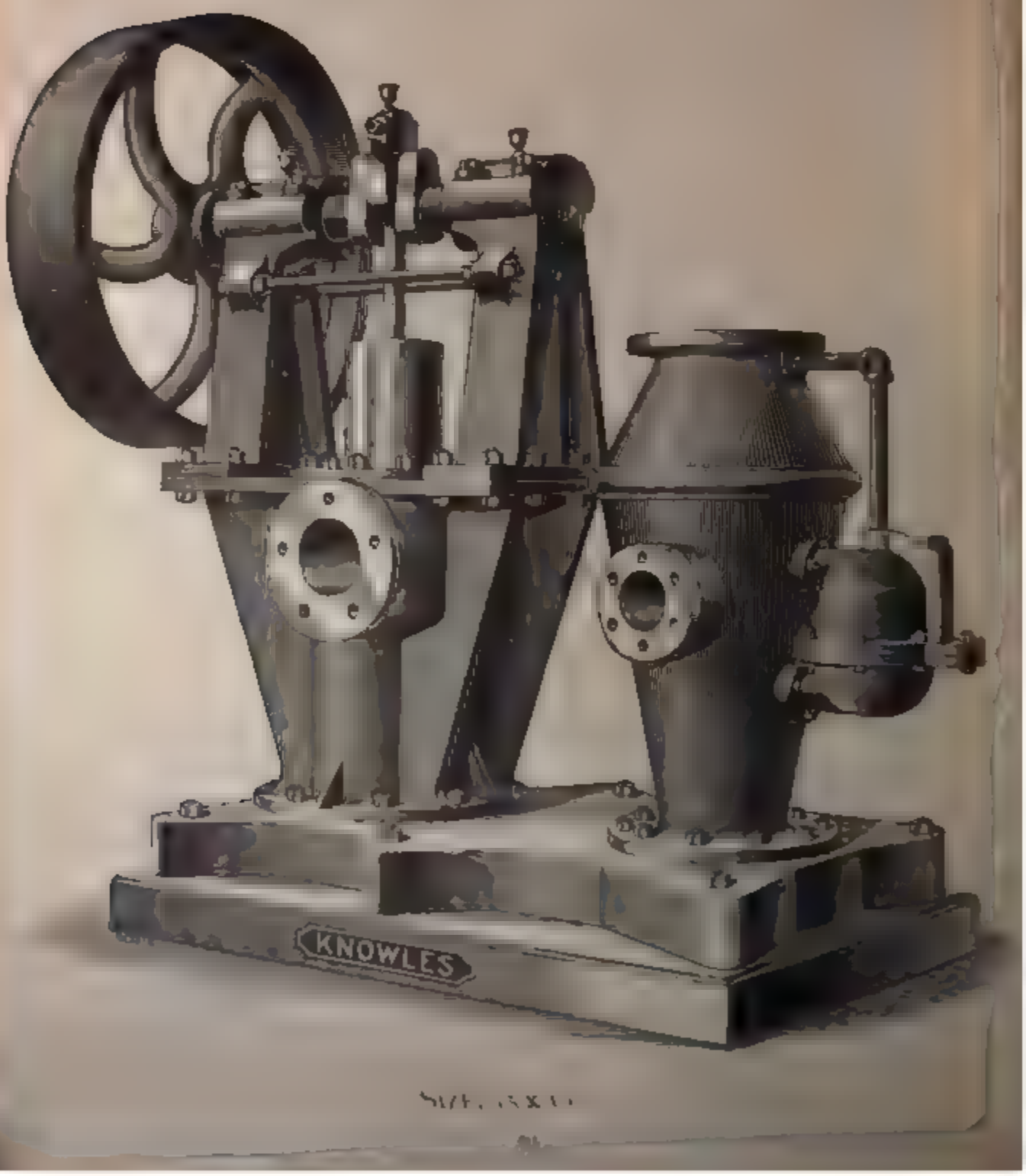
Triplex "Suction-Valveless" Electric Air Pumps, Double-Acting, with Jet Condenser.

Diameter of Air Cylinders.	Stroke.	Discharge Opening.	Revolutions per Minute	Surface Condensing.			Jet Condensing.						Dimensions Over All, Surface Condensing.			Dimensions Over All with Jet Condenser.			Telegraphic Code Word.	
				Steam per Hour, Lbs.	H. P. Motor Required	Revolutions per Minute, Motor.	Steam per Hour, Lbs.*	H. P. Motor Required.	Revolutions per Minute, Motor	Size of Condenser.	Exhaust Inlet	Injection.	A	B	C	A	B	C	Arranged for Surface Condenser.	With Jet Condenser.
8	6	5	100	21000	12	600	5000	15	600	15"	To Suit Exhaust Pipe of Engine	4	6' 0"	3' 5"	7' 10"	6' 0"	6' 0"	8' 2"	Libabit	Liasicas
8	8	5	100	25000	15	600	6700	20	600	18"		5	6' 5"	3' 5"	8' 10"	6' 5"	6' -"	9' 2"	Libabits	Liasique
10	8	8	100	43000	25	570	10300	30	570	21"		6	7' 0"	3' 11"	9' 10"	7' 0"	6' 10"	10' 2"	Libabant	Liaskalk
12	8	10	100	62000	35	570	15000	40	570	24"		7	7' 6"	4' 6"	11' 4"	7' 6"	7' 6"	11' 8"	Libadiorum	Liassic
14	8	12	100	85000	50	570	20200	55	570	36"		8	8' 2"	5' 1"	13' 5"	8' 2"	8' 2"	13' 0"	Libage	Liassiez
16	12	14	100	165000	90	550	34600	100	550	30"		10	9' 10"	5' 9"	15' 5"	9' 10"	8' 10"	16' 0"	Libandorum	Liassions
18	12	16	100	210000	120	550	50500	130	550	36"		12	10' 6"	6' 6"	16' 8"	10' 6"	9' 6"	17' 0"	Libanten	Liasstein

* The capacities of the jet system are figured with the injection water at a temperature not exceeding 60° Fahrenheit, and in case of warmer or colder water, larger or smaller sizes should be selected.

Knowles Vertical Single Power Air Pump and Jet Condenser.

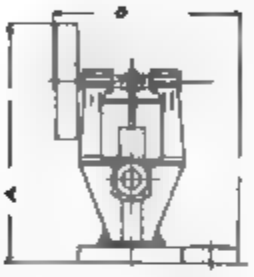
Belted Pump. Single-Acting Pattern.



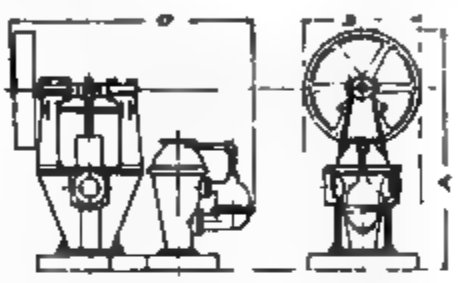
Knowles Vertical Single Power Air Pumps (Single-Acting Pattern).

THE arrangement generally used for small or medium powers is illustrated by cut on opposite page, this being our special design of vertical single power air pump, jet condensing. It can be used equally well with a surface condenser. The air pump is driven from the main shaft of the engine, or from any other convenient shaft connection, preferably by a belt. The air cylinder is the single-acting type, arranged with head and bucket valves, access to same being made easy by conveniently located handholes. No foot valves furnished unless specially ordered, and then at an extra price. The condenser is our latest improved pattern, and provided with our patent "break vacuum" safety attachment. The pump is regularly fitted as follows: Cast-iron bucket, with fibrous packing and composition follower, cast-iron bucket pump rod, composition valve seats, and cast-iron head valve plate. The extended bed-plate, which supports both cylinder and condenser, also serving as the suction box for pump, makes a very rigid foundation. The fly-wheel pulley is made heavy to insure a steady and even motion of the working parts. The pedestals for the main bearings are made very rigid and are securely tied together. The machine is so designed that solidity and compactness are attained without loss of accessibility of parts. The best of materials are used and careful attention is given to test of pump. If so ordered, we will furnish, at extra price, a friction clutch on the shaft for the purpose of throwing the pump in or out of service. For salt water injection the pump should have composition head valve plate instead of cast-iron plate as usually furnished for fresh water. The bucket and bucket pump rod should also be of composition.

These parts will be furnished of composition, at an additional price.



Vertical Single Power Air Pump, for Surface Condenser.



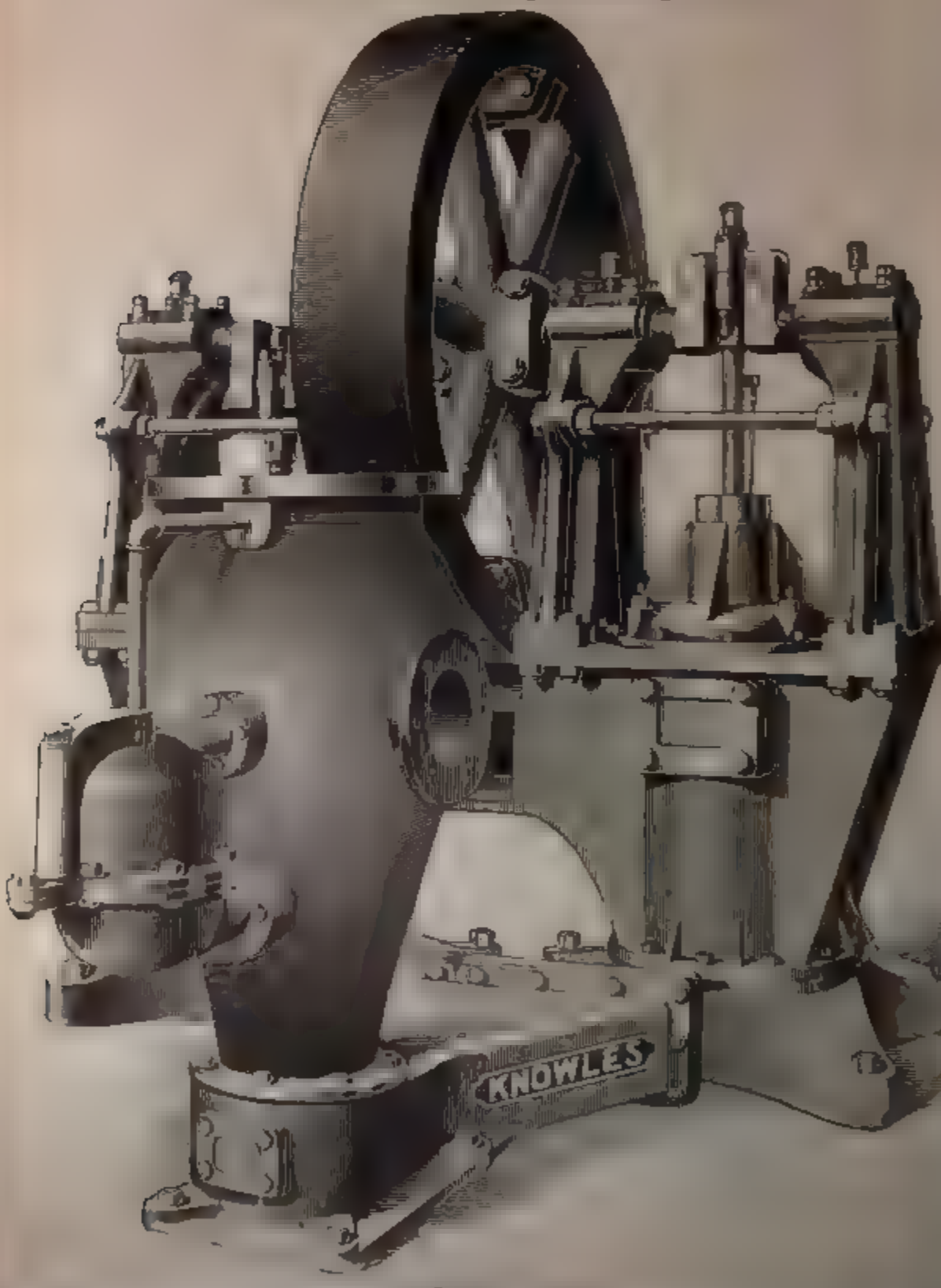
Vertical Single Power Air Pump with Jet Condenser.

Diameter of Air Cylinder.	Stroke.	Revolutions per Minute.	Pulley Diameter.	Pulley Face.	Surface Condensing. Suction.	Surface Condensing. Discharge.	Surface Condensing. Steam per Hour, Lbs.	Jet Condensing. Discharge.	Jet Condensing. Size of Condenser.	Jet Condensing. Injection.	Jet Condensing. Exhaust Opening.	Jet Condensing. Steam per Hour, Lbs.	To Suit Exhaust Pipe of Engine.	Dimensions Over All Arranged for Surface Condenser. A	B	C	Dimensions Over All with Jet Condenser. A	B	C	Telegraphic Code Word. Arranged for Surface Condenser.	With Jet Condenser.
8	8	60	30	4½	3½	2	2175	3	10	2		430		5′ 3″	3′ 6″	3′ 10″	5′ 3″	2′ 6″	5′ 0″	Leschbak	Lercaste
		50					2720					537								Leschbratk	Lercatum
9	8	60	36	4½	3	2½	2750	3	10	2		544		5′ 6″	3′ 0″	3′ 11″	5′ 6″	3′ 0″	5′ 1″	Leschtrog	Lerdanas
		50					3440					680								Leschtug	Lerdant
10	8	60	36	5½	3	2½	3400	4	10	3		673		5′ 6″	3′ 0″	4′ 1″	5′ 0″	3′ 0″	5′ 3″	Leschwater	Lerget
		50					4250					840								Lesclache	Lerste
12	8	80	36	5½	3½	3	4900	4	12	3		697		5′ 8″	3′ 0″	4′ 4″	5′ 8″	3′ 0″	5′ 6″	Lesesart	Lermmer
		50					6130					1210								Leschuch	Lernaeadae
13½	8	80	36	5½	4		6200	5	12	3		1223		5′ 10″	3′ 0″	4′ 6″	5′ 10″	3′ 0″	5′ 8″	Leseknecht	Lernaeos
		50					7750					1530								Leseha le	Lerthates
15	10	80	48	6½	5	4	9450	6	15	4		1866		6′ 9″	4′ 0″	5′ 0″	6′ 1″	4′ 0″	6′ 7″	Leschelz	Lernberger
		50					12000					2360								Leschelzes	Lernettes
16	10	80	48	7	5		10140	6	15	4		2160		6′ 10″	4′ 0″	5′ 4″	6′ 10″	4′ 0″	6′ 10″	Leseka mmer	Lernen
		50					13700					2700								Leseka ranz	Lerneomyze
17	10	80	39	7	6	5	12400	7	18	5		2430		5′ 4″	4′ 4″	5′ 5″	7′ 4″	4′ 4″	6′ 11″	Leselkunst	Lernenoene
		50					15400					3040								Leselust	Lernopoale
17½	10	80	52	7	6	5	13050	8	18	5		2575		7′ 0″	4′ 4″	5′ 7″	7′ 0″	4′ 4″	7′ 1″	Leselustig	Lernelder
		50					16300					3220								Leseolist	Lerngter
20	10	80	52	10	7	6	17000	9	18	5		3360		7′ 8″	4′ 4″	6′ 0″	7′ 6″	4′ 4″	7′ 8″	Leseobstes	Lernge rig
		50					21300					4200								Leseplat	Lernzeit
22	10	80	52	12	7	6	20700	9	21	6		4080		7′ 10″	4′ 4″	6′ 2″	7′ 10″	4′ 4″	8′ 2″	Lesepulten	Lernzeiten
		50					25900					5100								Leseriez	Lesao
25	10	80	66	12	7	6	26700	10	24	7		5260		8′ 3″	5′ 6″	6′ 9″	8′ 5″	5′ 6″	8′ 4″	Leserkreis	Lesarten
		50					33400					6600								Leserent	Lesasses
28	10	80	66	15	8	6	33400	10	24	7		6600		8′ 6″	5′ 6″	7′ 3″	8′ 6″	5′ 6″	9′ 3″	Leserauhe	Leshare
		50					41800					8250								Leserwell	Lesblaci
30	10	80	52	12	7	6	20400	9	18	5		4030		8′ 2″	4′ 4″	6′ 2″	8′ 2″	4′ 4″	7′ 10″	Leserzahn	Leshiacuam
		50					25600					5060								Leserzeit	Leshiacire
32	12	80	52	14	7	6	24800	9	21	6		4980		8′ 4″	4′ 4″	6′ 4″	8′ 4″	4′ 4″	8′ 4″	Leserzine	Leshiacisa
		50					31000					6100								Leserzwei	Leshiacita
28	12	80	66	14	7	6	33000	10	24	7		6320		9′ 0″	5′ 6″	6′ 11″	9′ 0″	5′ 6″	9′ 0″	Leseszat	Leshiacizo
		50					41000					7900								Leseszbar	Leshiacoja
30	12	80	84	18	10	8	53500	12	36	8		10350		10′ 3″	7′ 0″	8′ 5″	10′ 3″	7′ 0″	10′ 5″	Leseschule	Leshlacca
		50					65800					12450								Leseuteu	Leshvacum

**The capacities of the jet system are based on injection water not exceeding 70° Fahrenheit. For southern or tropical waters, select one size larger or higher speed pump. For well or spring water, select one size smaller or lower speed pump.*

Knowles Vertical Duplex Power Air Pump and Jet Condenser.

Belted Pump. Single-Acting Pattern.

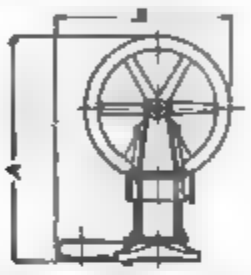


Size, 17½ x 10.

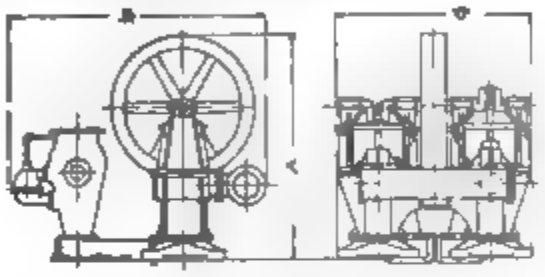
Knowles Vertical Duplex Power Air Pumps (Single-Acting Pattern).

ON pages 84 and 85 we described our single power air pump. In addition to this type we also manufacture a somewhat similar machine which has two vertical single-acting air cylinders, both connecting with one condenser shown by cut on opposite page. This type is especially useful in connection with steam engines of large size where power-driven air pump is desired. It may be used with jet or surface condenser. In this type the cranks are opposite so that when one bucket is on its down stroke the other is on its up stroke. To insure satisfactory service, a power-driven air pump must be very rigid and well built. This design of machine fills all requirements. Both cylinders are supported by a rigid base, which also serves as the suction box for both pumps. When used with a jet condenser this base is extended to support the same, and the passages are so arranged that there will be a free flow from condenser to the cylinders, doing away with any surging from one cylinder to the other. The condenser is our latest improved pattern and is provided with patent break vacuum safety attachment. The heavy hand-wheel is of suitable size to insure smooth running. The bearings and all working parts are adjustable for wear. The buckets, bucket pump rods, and head valve plates are either cast-iron or composition, according to whether fresh or salt water is used for injection. These parts will be furnished of composition when salt water is used, at an additional price. All valves are accessible through conveniently located handholes.

If so ordered, we will furnish, at extra price, a friction clutch on the shaft for the purpose of throwing the pump in or out of service.



Vertical Duplex Power Air Pump, for Surface Condenser.



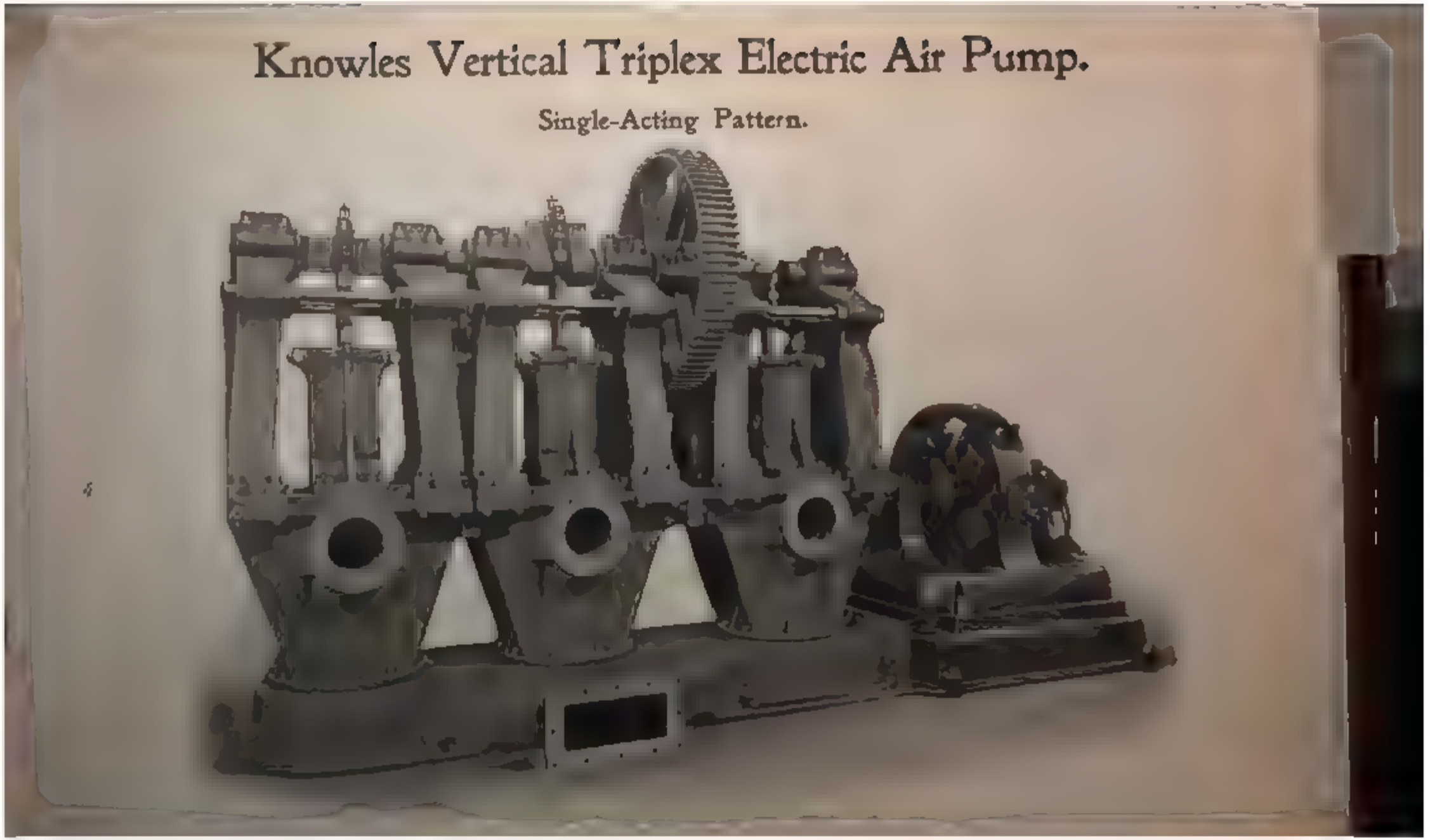
Vertical Duplex Power Air Pump, with Jet Condenser

Diameter of Air Cylinder	Stroke	Revolutions per Minute	Pulley. Diameter.	Pulley. Face	Surface Condensing. Suction	Surface Condensing. Discharge	Surface Condensing. Steam per Hour, Lbs.	Jet Condensing.* Discharge	Jet Condensing.* Size of Condenser	Jet Condensing.* Injection Exhaust Opening	Jet Condensing.* Steam per Hour, Lbs.*	Type of Engine	Dimensions Over All, Arranged for Surface Condenser A	B	C	Dimensions Over All with Jet Condenser A	B	C	Telegraphic Code Word: Arranged for Surface Condenser	With Jet Condenser
8	8	40	24	6	3½	3	4350	4	12	3	660		5' 9"	3' 9"	5' 12"	5' 5"	4' 11"	5' 11"	Letaberis	Lesgeven
		50					5440				1074								Letabor	Lesgevers
9	8	40	28	6	4	3½	5500	4	12	3	1098		5' 10"	3' 2"	6' 1"	5' 10"	5' 3"	6' 1"	Letabentur	Leshem
		50					6880				1380								Letabus	Leshem
10	8	40	34	6	4	3½	6800	5	12	3	1346		6' 1"	3' 8"	6' 4"	6' "	5' 8"	6' 3"	Letal om	Lesmer
		50					8500				1680								Letamamino	Lesmerta
12	8	40	48	6	5	4	9800				1934		6' 8"	4' 11"	6' 7"	6' 8"	5' 8"	6' 7"	Letamanlo	Lesvas
		50					12269	5	15	4	2420								Letamarono	Lesies
13¼	8	40	48	8	6	5	12400	6	15	4	2446		6' 10"	5' 0"	6' 1"	6' "	5' 2"	6' 11"	Letamassi	Lesora
		50					15500				3060								Letamavamo	Lespecze
15	10	40	60	8	7	6	19100				3776		7' 0"	5' 1"	7' 2"	7' 10"	5' 4"	7' 2"	Letamavate	Lesque
		50					24000	7	21	6	4720								Letamefai	Lesvassi
16	10	40	60	9	7	6	21880	7	21	6	4320		7' 0"	6' 2"	7' 5"	7' "	5' 4"	7' 5"	Letamimano	Lesavano
		50					27400				5400								Letamivare	Lesseding
17	10	40	66	10	7	6	24600	8	24	7	4860		7' 1"	6' 2"	7' 5"	7' 8"	5' 5"	7' 8"	Letamivava	Lesseraars
		50					30800				6080								Letamino	Lesseremmo
17½	10	40	66	10	8	7	26100	9	24	7	5150		8' 1"	6' 5"	8' "	8' 1"	5' 1"	8' 0"	Letamosa	Lesseraste
		50					32600				6440								Letandarom	Lessero
20	10	40	72	12	8	7	34000	10	24	7	6720		8' 2"	7' 2"	8' 3"	8' 2"	5' 2"	8' 3"	Letanies	Lesserta
		50					42600				8400								Letaresis	Lessiano
22	10	40	72	14	9	8	47400	12	26	8	8360		8' 9"	7' 5"	8' 6"	8' 9"	5' 10"	8' 8"	Letargeche	Lessigie
		50					59200				10200								Letasini	Lessive
25	10	40	72	18	10	9	54400	14	30	10	10560		8' 9"	7' "	8' 9"	8' 9"	6' "	8' 9"	Letaturom	Lessiveur
		50					68000				13200								Letchi	Lestaas
28	10	40	84	18	12	10	69400	14	30	10	13200		9' 3"	8' 7"	10' 0"	9' 1"	6' 11"	9' 1"	Letellier	Lesteriez
		50					83400				16500								Teteo	Lestique
20	12	40	72	14	8	7	48900	10	24	7	8360		9' 0"	7' 2"	9' 4"	9' 1"	6' 0"	9' 4"	Letepas	Lestiraan
		50					73300				10500								Leteoquire	Lesturbete
22	12	40	72	18	9	8	59600	12	26	8	9270		9' 1"	7' 5"	9' 8"	9' 2"	6' 0"	9' 8"	Letepatus	Lestreese
		50					89400				12960								Letepora	Lestusara
25	12	40	84	18	10	9	84000	14	30	10	12960		9' 9"	7' 9"	9' 11"	9' 9"	6' 9"	9' 11"	Letestem	Lestisbam
		50					126000				15800								Letetag	Lestisca
32	12	40	96	25	14	12	105000	16	36	12	20700		10' 4"	9' 0"	11' 5"	10' 4"	8' 12"	11' 5"	Letetur	Lestisimo
		50					157500				25000								Lethaeisch	Lestremie

*The capacities of the jet system are based on injection water not exceeding 70° Fahrenheit. For southern or tropical waters, select one size larger or higher speed pump. For well or spring water, select one size smaller or lower speed pump.

Knowles Vertical Triplex Electric Air Pump.

Single-Acting Pattern.



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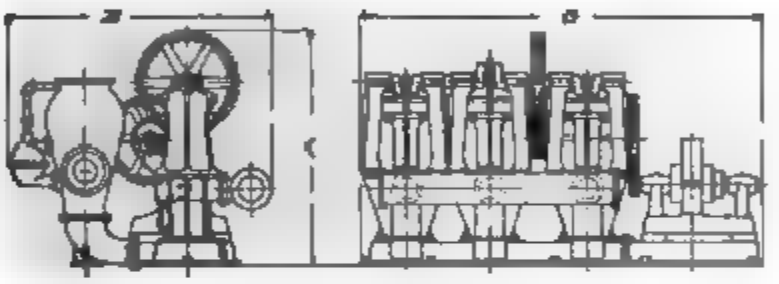
Vertical Triplex Electric Air Pumps (Single-Acting Pattern).

...ally driven pump is preferred we recom-...n shown on opposite page. This pump ...gle-acting air cylinders and is driven by ... motor. Like the single and duplex types, ...t or surface condenser. Cut shows pump ...ondenser. The motor may be arranged at ...mp, as preferred. The dimensions given ...r placed at end of pump, as shown by cut. ...e, which is also the suction box for all ...oth pump and motor. The jet condenser ...ing" attachment for this pump are the previous types. When salt water is used ...se parts must be furnished of composi-...rics, as in the single and duplex types. ...es are of cast-iron and have machine-cut teeth, but we will furnish a fibre pinion for the armature shaft, to reduce noise to a minimum, if so ordered, at extra price. This type, in common with the single and duplex, has the following advantages of construction: Steel connecting rods with babbitted box on crank end, ample babbitted bearings for main shaft, and adjustments on all wearing parts. On account of its design it occupies a very limited space. In selecting the electric motors of suitable horse-power for driving the pumps, careful attention must be given to all details of each installation, especially with regard to head, if any, on discharge valves. The horse-power stated is approximate only.

NOTE.—We build the above for light pressures, such as circulating service in connection with surface condensers, etc., etc., for which we will be pleased to give special figures on receipt of information.

...lectric Air Pump, ...Condenser.



Vertical Triplex Electric Air Pump. with Jet Condenser.

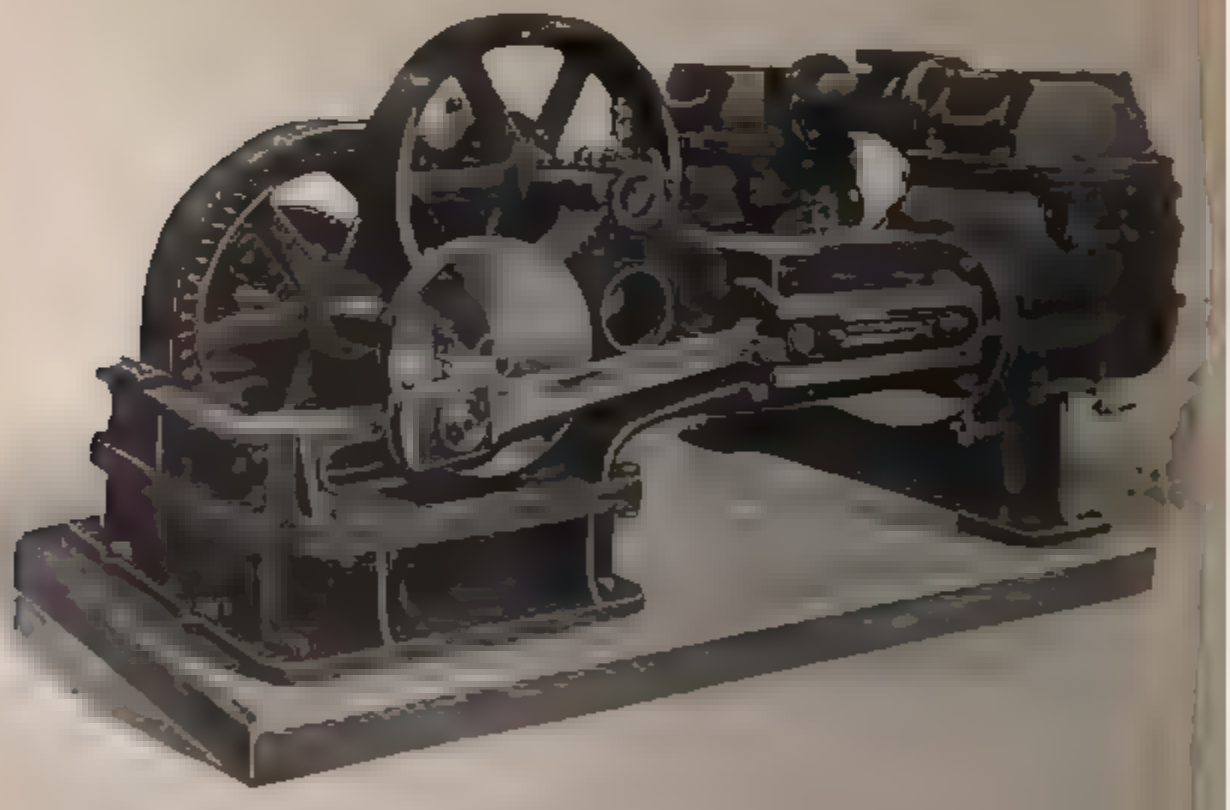
...ace ...ming.			Jet Condensing					Dimensions Over All, Arranged for Surface Condenser.			Dimensions Over All, with Jet Condenser			Telegraphic Code Word.	
Required.	Suction.	Discharge.	Steam per Hour Lbs.	H P Motor Required.	Discharge.	Size of Condenser	Exhaust Inlet. Injection	A	B	C	A	B	C	Arranged for Surface Condenser	With Jet Condenser
5	4	3	1350 1611	7½	5	12	3	5' 6"	3' 9"	12' 6"	5' 6"	4' 7"	12' 6"	Libarium	Libica
5	5	4	1632 2040	7½	5	12	3'	5' 9"	4' 0"	13' 0"	5' 9"	5' 2"	12' 0"	Libasti	Libicos
7½	5	4	2010 2520	10	6	15	4	6' 0"	4' 3"	13' 3"	6' 0"	6' 8"	13' 3"	Libatarum	Libidibi
7	6	5	2520 3024	15	6	15	4	6' 3"	4' 4"	13' 8"	6' 3"	6' 10"	13' 10"	Libation	Libidinari
5	7	6	3024 4300	20	7	18	5	6' 9"	4' 6"	14' 0"	6' 5"	7' 0"	14' 2"	L batonem	Libidinem
8	8	7	4300 5264	25	8	21	6	7' 5"	4' 8"	14' 4"	7' 0"	7' 4"	14' 7"	Libations	Libidinor
9	9	8	5264 6480	30	10	24	7	7' 8"	5' 3"	14' 9"	7' 3"	8' 1"	15' 5"	L batrice	Libidocice
9	9	8	6480 8100	35	10	24	7	8' 3"	5' 3"	14' 9"	7' 8"	8' 1"	15' 5"	Libatum	Libisosa
9	9	8	7290 9180	35	10	24	7	8' 3"	5' 9"	15' 1"	8' 3"	8' 7"	15' 4"	L baturous	Libitum
9	10	9	7725 9660	25	12	26	8	8' 3"	5' 10"	15' 1"	8' 3"	9' 0"	15' 6"	Libaverat	Libnah
9	10	9	10080 12600	40	14	30	10	9' 8"	6' 9"	15' 10"	8' 6"	9' 3"	16' 2"	Libaverant	Libocedre
5	12	10	12240 15300	45	14	30	11	8' 9"	6' 8"	16' 4"	8' 9"	9' 10"	16' 10"	Libavimus	Libongo
5	12	10	13780 17200	55	16	36	12	8' 10"	7' 3"	17' 4"	8' 10"	10' 4"	17' 10"	Libavo	Libonati
5	14	12	16900 21750	70	18	40	14	9' 0"	7' 10"	18' 4"	9' 0"	11' 4"	18' 10"	Libavisset	Libonotos
5	14	9	12900 15150	45	14	30	10	9' 10"	6' 4"	16' 0"	9' 10"	9' 6"	16' 4"	Libavisti	Libonorum
2	12	10	14640 18300	55	14	36	10	10' 0"	6' 10"	16' 6"	10' 0"	9' 10"	17' 0"	Libecchio	L bouret
5	12	10	17360 21700	70	16	36	12	10' 3"	7' 4"	17' 8"	10' 3"	10' 4"	18' 2"	Libelatico	Librabis
5	16	14	23760 31680	110	20	40	14	10' 10"	8' 9"	19' 11"	10' 10"	11' 8"	21' 0"	Libellant	Librabitur
														Libellaria	Libradiga
														Libellarum	Libramen
														Libellensi	Libramina
														Libellinha	Libraminis
														Libellioni	Librarioli
														L libellous	Librarios
														Libelliqua	Librarista
														Libentibus	Librasels
														Liberatine	Librasen
														Liberatione	Librated
														Liberabit	Libratores
														Liberacion	Libratory
														Liberalaa	Libratiole
														Liberalesa	Libratura
														Liberalism	Libratoria
														Liberalsum	Libravi

...of the jet system are based on injection water not exceeding 70° Fahrenheit. For summer or tropical waters, ...r or higher speed pump. *For well or spring water*, select one size smaller or lower speed pump.

Knowles
Horizontal Duplex Power Vacuum Pump

FOR VACUUM PAN SERVICE.

Belted Pump. Double-Acting Piston Pattern.



SIZE, 10 X 10.

Gear Guard furnished only when specially ordered, and at additional price.

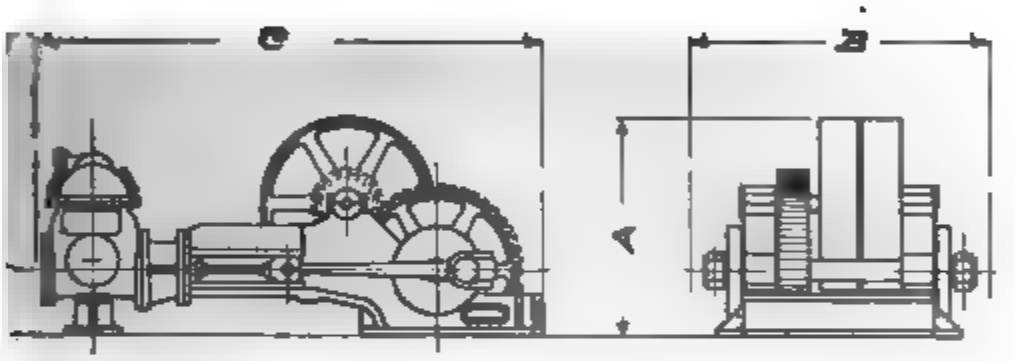
Knowles Horizontal Duplex Power Vacuum Pumps.

For Vacuum Pan Service.

Double-Acting Piston Pattern.

THE cut of a 10 x 12 Duplex Power Vacuum Pump, as sometimes built without basin heads, is shown on opposite page. Basin heads, however, are usually furnished. These consist of protruding water basins on inside cylinder heads, which surround and seal the stuffing-boxes, thus preventing leakage of air through the gland to impair the vacuum when the pump is in operation. Tight and loose pulleys are usually furnished as shown by outline drawing. The perfectly uniform and positive length of stroke, with the consequent small clearance in vacuum cylinders, make this class of pumps most efficient in producing high vacuum. Pumps of this design may be used on either the "wet system," where all water used for condensing passes through the pump, or on the "dry system," where the "barometrical column" or leg pipe carries off the injection water by gravity from the bottom of the condenser without passing through the pump. These pumps are usually run in sugar houses by countershaft or by belt from motor, but can be furnished with gearing to connect directly with motor, for special inquiries, for which we will be pleased to give special figures.

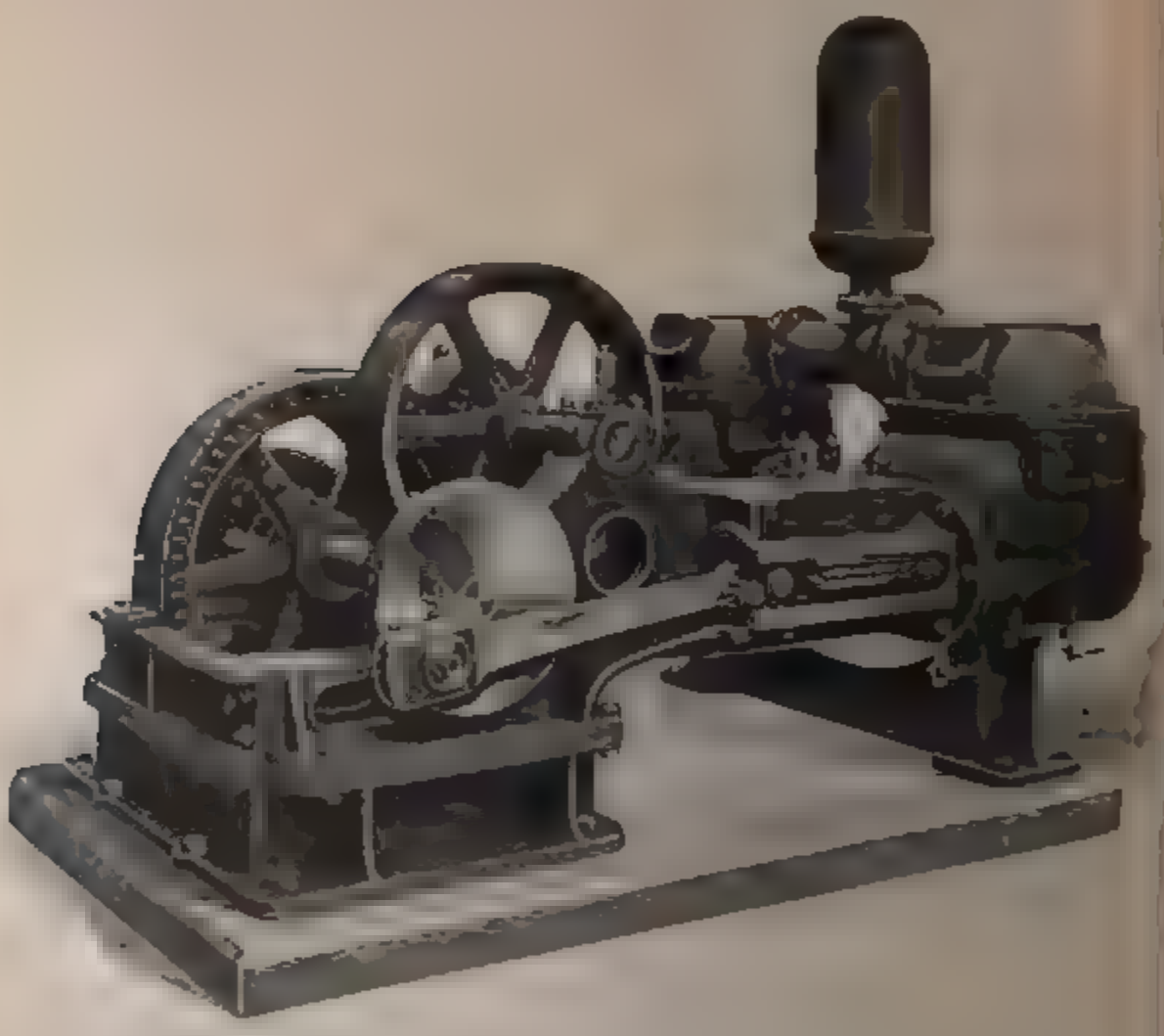
Points of construction:—Close clearance vacuum cylinders with composition linings, composition pistons with adjustable packing, composition piston rods, valve seats and bolts, steel connecting rods, machine cut gears, cranks at right angles, adjustment for all wearing parts, and best material. Gear guard shown in cut not furnished unless ordered, at additional price. When ordering please inform us (1) if the vacuum pump is for "wet" or "dry" system; (2) diameter of pan or evaporator and amount of heating surface in same; (3) character of material and quantity to be evaporated per hour in the evaporator, and (4) average temperature of the injection water for the condenser.



Diameter of Cylinder.	Stroke.	Pulleys, Tight and Loose. Diam	Face	Suction.	Discharge.	Ratio of Gears.	Dimensions Over All. A	B	C	Telegraphic Code Word.
6	10	30	4	5	5	3.75 to 1	2' 9"	4' 6"	6' 10"	Malava
6	12	36	4	5	5	3 75 to 1	3' 0"	4' 6"	6' 10"	Malavindo
10	10	30	5	5	5	3 75 to 1	3' 2"	4' 8"	7' 1"	Malavise
6	12	30	5	6	6	3 75 to 1	3' 4"	5' 0"	6' 10"	Malaxabit
10	12	30	6	6	6	3 75 to 1	3' 4"	5' 2"	7' 10"	Malaxabunt
10	12	36	6¼	6	6	3.75 to 1	3' 10"	5' 3"	7' 10"	Malaxage
10	12	40	6½	8	6	3 75 to 1	4' 0"	5' 5"	7' 10"	Malaxamus
10	12	36	6½	10	8	5 to 1	4' 2"	5' 7"	7' 10"	Malaxandos
10	12	36	6½	12	10	5 to 1	4' 10"	6' 7"	9' 6"	Malaxarent
10	12	40	8½	12	10	5 to 1	4' 10"	7' 4"	10' 0"	Malaxation
10	12	40	10	12	10	5 to 1	5' 2"	7' 9"	10' 4"	Malaxatura
10	12	48	10	12	10	5 to 1	5' 6"	8' 0"	10' 8"	Malaxavero

Knowles
Horizontal Duplex Power Syrup Pump.

Belted Pump. Double-Acting Piston Pattern.



SIZE, 10 X 10

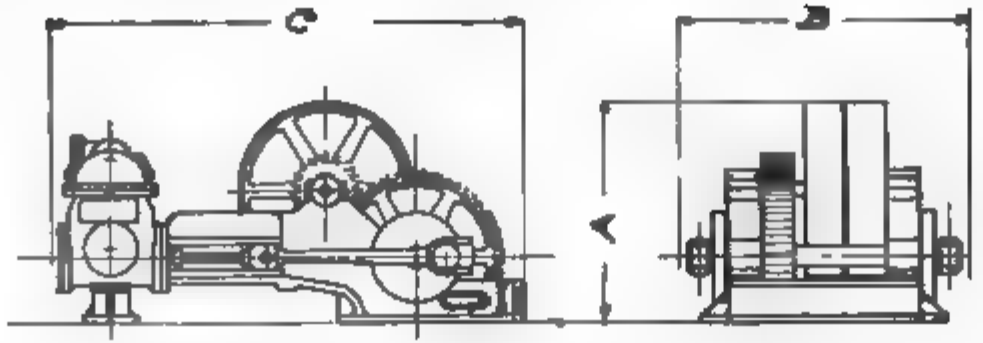
Gear Guard furnished only when specially ordered, and at additional price.

and

Horizontal Duplex Power Syrup Pumps,

Double-Acting Piston Pattern.

THE cut opposite represents a 10 x 10 duplex power syrup pump, and the same pump with air chamber left off is used for "sweet water" On both pumps tight and loose pulleys are furnished as shown by outline drawing. The syrup pump, which is usually located 20 to 35 feet below pan, is arranged to pump the hot syrup from the pans, which are under a vacuum of 26 to 28 inches the pump delivering the syrup against a head of 25 to 30 feet The "sweet water" pumps are especially designed for removing the "sweet water" condensed in the heating drums or coils of a double or multiple effect, and pull a vacuum therein of 12 to 20 inches, discharging into an open pipe or drain. No air chamber is used, as shown by outline drawing Both pumps have cylinders of the "close-clearance" type with composition linings, composition pistons, piston rods, valve seats and bolts, steel connecting rods machine-cut gears, cranks at right angles, and adjustment for all wearing parts. In sugar houses, both types are generally run by countershaft, or by belt from motor, but can be furnished direct connected to motor by gears. When so arranged we prefer to give special figures for same. Gear guard, shown in cut, not furnished unless specially ordered, at additional price.



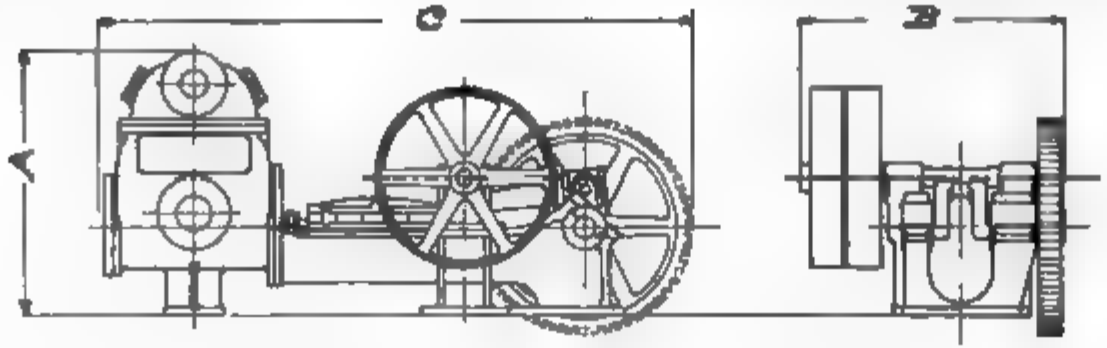
Diameter of Cylinders.	Stroke.	Pulleys, Tight and Loose				Suction	Discharge.	Ratio of Gears.	Dimensions Over All for "Sweet Water" Pumps.			Dimensions Over All for Syrup Pumps.			Telegraphic Code Word.	
		"Sweet Water."		Syrup					A	B	C	A	B	C	"Sweet Water" Pumps.	Syrup Pumps.
		Diam.	Face.	Diam	Face.											
6	6	20	4	20	5	5	5	3·25 to 1	2′ 4″	4′ 6″	6′ 2″	4′ 1″	4′ 8″	6′ 2″	Malharato	Malcham
8	6	26	4	26	6½	6	5	3·75 to 1	3′ 0″	4′ 6″	6′ 2″	4′ 9″	4′ 10″	6′ 2″	Malbarer	Malchance
8	10	30	5	30	6	6	5	3·75 to 1	3′ 2″	4′ 8″	7′ 2″	4′ 9″	4′ 10″	7′ 2″	Malbeck	Malchiah
10	6	30	5	30	6	8	7	3·75 to 1	3′ 4″	5′ 0″	6′ 2″	5′ 6″	5′ 2″	6′ 2″	Malblad	Malchion
10	10	30	6	36	7	8	7	3·75 to 1	3′ 4″	5′ 2″	7′ 2″	5′ 6″	5′ 4″	7′ 2″	Malbladen	Malchiram
12	10	36	6½	48	7	10	8	3·75 to 1	3′ 10″	5′ 3″	7′ 2″	6′ 2″	5′ 4″	7′ 2″	Malbroeken	Malcolmie
12	10	40	6½	48	10	10	8	3·75 to 1	4′ 0″	5′ 5″	7′ 2″	6′ 4″	6′ 0″	7′ 2″	Malbrouk	Malcomias
14	10	36	6½	48	12	12	10	3·75 to 1	4′ 2″	5′ 7″	7′ 2″	7′ 2″	6′ 6″	7′ 2″	Malcasado	Malcomido

Knowles Horizontal Power "Sweet Water" Pump.

Belted Pump. Double-Acting Single Cylinder Pattern.

Double-Acting Single Cylinder Pattern.

ONE of our single power "sweet water" pumps is illustrated on opposite page, and the same pump with addition of air chamber is used as a syrup pump. On both pumps tight and loose pulleys are furnished, as shown by outline drawing. In table of sizes below all pumps of 6 and 7 inch stroke have flat cap pump ends, like cut shown on page 56. All of 10 and 12 inch stroke have "close-clearance" pump ends, except the 6 x 12, which has flat cap end. Cut opposite shows "close-clearance" pump end. For removing the "sweet water" condensed in the heating drums or coils of a double or triple effect the "sweet water" pumps are used, arranged to pull a vacuum of 12 to 20 inches and discharge into an open pipe or drain, therefore requiring no air chamber. The syrup pump which is usually located 20 to 25 feet below pan is arranged to pump the hot syrup from the pans which are under a vacuum of 26 to 28 inches, the pump delivering the syrup against a head of 25 to 30 feet. Both types are generally run by a countershaft, or by belt from motor, but can be furnished direct connected to motor by gearing. When so arranged we prefer to give special figures for same. Pumps have composition linings, pistons, piston rods, valve seats and bolts, steel connecting rods, machine-cut gears, and adjustments in all wearing parts. The equalizing valves shown in cut are furnished only on "sweet water" pumps.



Diameter of Cylinder	Stroke.	Pulleys, Tight and Loose "Sweet Water." Diam.	"Sweet Water." Face.	Syrup Diam	Syrup Face	Suction	Discharge	Ratio of Gears	Dimensions Over All for "Sweet Water" Pumps A	B	C	Dimensions Over All for Syrup Pumps A	B	C	Telegraphic Code Word "Sweet Water" Pumps	Syrup Pumps
6	6	16	4	14	4	3	2	3 to 1	2' 5"	2' 8"	6' 3"	5' 4"	2' 8"	6' 2"	Maleabais	Malefabras
6	12	20	4	28	5	3	2	4 to 1	2' 5"	2' 8"	6' 9"	5' 4"	2' 10"	6' 9"	Maleachi	Malefabrum
8½	7	18	4	26	4	4	3	3 to 1	2' 6"	2' 9"	6' 6"	5' 4"	3' 0"	6' 6"	Maleadoras	Malefaclet
8½	7	20	4	28	5	4	3	3 to 1	2' 6"	2' 9"	6' 6"	5' 5"	3' 3"	6' 6"	Malearian	Malefactos
9	10	20	5	24	6	5	4	1 to 1	2' 6"	3' 0"	6' 6"	5' 9"	3' 2"	6' 9"	Maleate	Malefactum
10	10	24	6	24	6	5	4	1 to 1	2' 6"	3' 2"	6' 9"	5' 8"	3' 2"	6' 9"	Malebete	Malefasm
10	12	24	6	24	6	5	4	1 to 1	2' 6"	3' 2"	6' 9"	5' 9"	3' 2"	6' 9"	Malebolge	Malefecero
11	10	24	6	28	6	5	4	4 to 1	2' 6"	3' 2"	6' 9"	5' 9"	3' 2"	6' 9"	Malebosse	Maleficate
11	12	24	6	28	6	5	4	4 to 1	2' 6"	3' 2"	6' 9"	5' 9"	3' 2"	6' 9"	Malebouche	Malefice
12	10	24	6	28	6	5	4	1 to 1	2' 7"	3' 3"	6' 9"	5' 9"	3' 3"	6' 9"	Malecasti	Maleficio
12	12	24	6	28	7	5	4	1 to 1	2' 7"	3' 3"	6' 9"	5' 9"	3' 3"	6' 9"	Malecastos	Malefidus
14	10	24	6	36	6	5	5	4 to 1	2' 8"	3' 6"	6' 10"	6' 2"	3' 6"	6' 10"	Malecastum	Malefigue
14	12	28	6	36	7	5	5	4 to 1	2' 8"	3' 6"	6' 10"	6' 2"	3' 8"	6' 10"	Malecones	Malegloute
16	12	36	6	40	10	8	6	4 to 1	3' 11"	3' 10"	7' 0"	6' 5"	4' 6"	7' 0"	Maledetung	Maleiteira
18	12	36	7	40	12	10	8	4 to 1	4' 4"	4' 3"	7' 3"	6' 10"	5' 0"	7' 3"	Maledicted	Maleteel

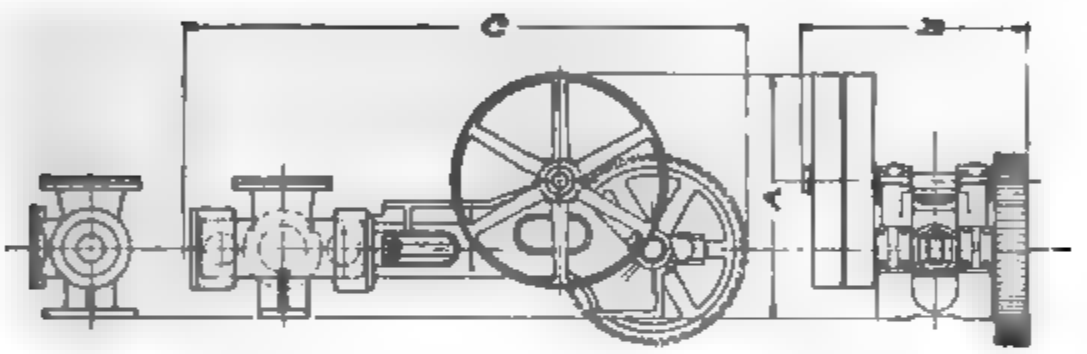
Knowles Single Power "Magma" Pump.

Double-Acting.

OUR latest Power "Magma" Pump is illustrated by the outline drawing, which shows a pump largely used in sugar houses to move the thick semi-fluids, vacuum pan products, etc., which must be handled in connection with such work. Its use is not confined, however, to this particular service, as it may be used equally well in plantation sugar houses for pumping wagon goods to tanks or wagons; and it can be satisfactorily employed in many other situations, where mixtures of pulp, ink, tar, etc., are to be moved or treated. In order to do this work successfully the pump must have very large passageways and the smallest possible number of working parts in the pump cylinder. To meet these requirements this type is constructed with a large suction opening, usually larger than the bore of the cylinder, opening downward directly into the centre of the pump cylinder. There are no suction valves in the pump. The piston travels by the large suction inlet, and after this opening is closed, all the material remaining between the piston head and the end of the cylinder is expelled through a special form of discharge valve arranged to give a large and free opening. The pump is double-acting, the same action occurring at the other end of cylinder during the return stroke. All wearing parts are provided with adjustment. Every part is carefully proportioned, and the material and workmanship are the very best obtainable. The cast-iron gear and pinion have machine-cut teeth, thus increasing smoothness of action and life of pump. Tight and loose pulleys are furnished. The connecting rod is of steel, having adjustable babbitted box on crank end, other end being provided with removable brass bushing. The frame is so designed that ample bearings are provided, and is tied to insure greater rigidity. These pumps require the fluid to come to them under a head. When sending inquiries or orders, always state elevation, nature of liquid and quantity to be *discharged*, etc.

Knowles Single Power "Magma" Pump.

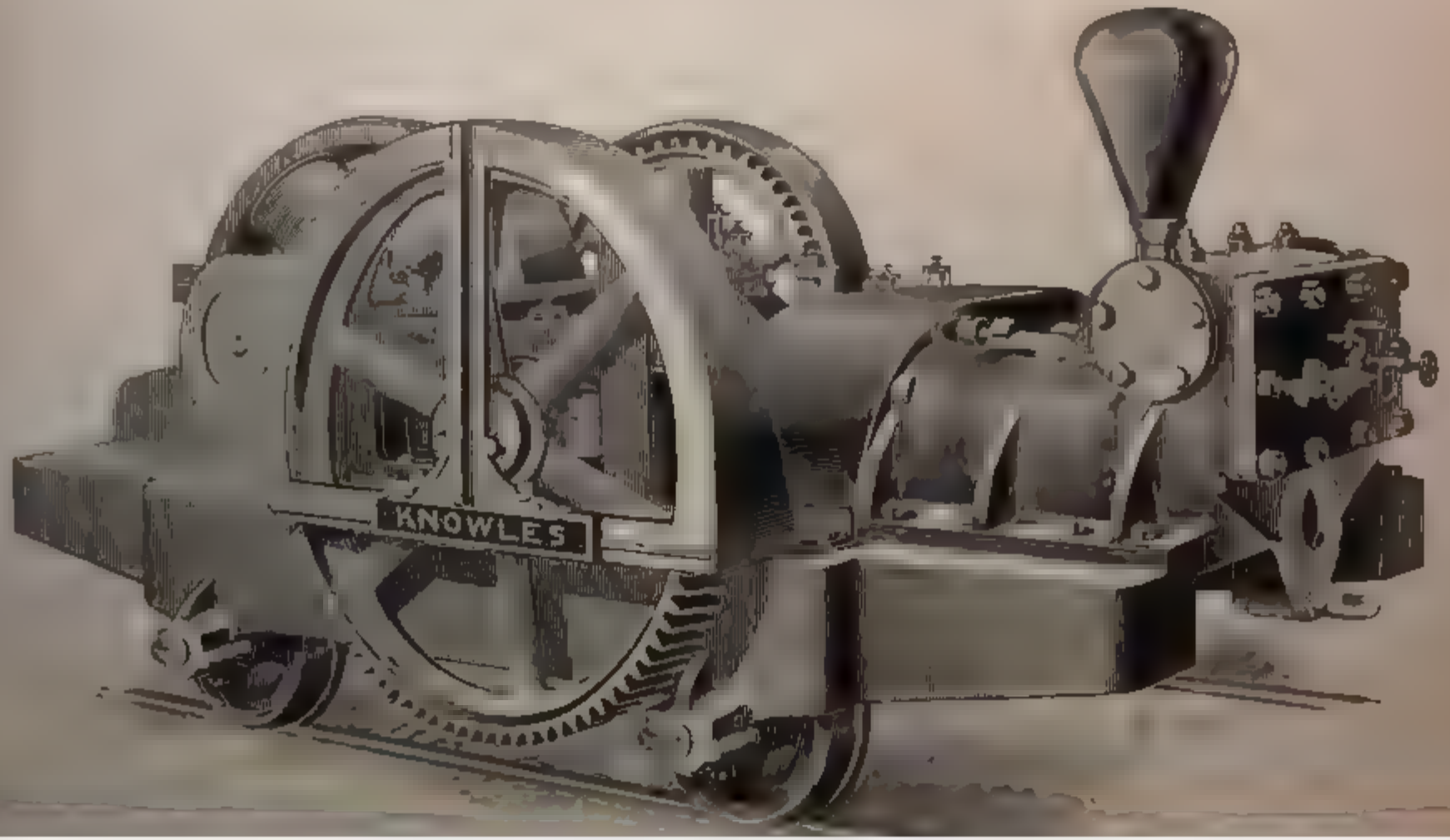
Double-Acting.



Stroke.	Pulleys, Tight and Loose. Diam.	Pulleys, Tight and Loose. Face.	Suction.	Discharge.	Ratio of Gears.	Dimensions Over All. A	Dimensions Over All. B	Dimensions Over All. C	Telegraphic Code Word.
10	12	3	6	6	3 to 1	2' 8"	2' 8"	7' 6"	Maldacon
12	36	4	6	6	3 to 1	3' 2"	2' 10"	7' 8"	Maldades
12	36	5	8	8	3½ to 1	3' 2"	3' 0"	7' 10"	Maldegeer
12	36	5½	10	8	3½ to 1	3' 5"	3' 1"	7' 10"	Malders

Knowles Triplex Portable Electric Power Mining Pump.

Horizontal, Single-Acting, Plunger Pattern.



THE cut shows a horizontal triplex pump complete with motor, mounted on an iron truck. No wood whatever is used in construction, so that alignment cannot be affected by moisture, and an easy running and durable pump is assured. This type of machine, while designed for mining service, will be found exceedingly convenient and economical for excavating and contracting purposes, where the pump must be moved frequently to keep pace with the progress of the work. Our experience in mine pumping, a service that is generally rough, severe and continuous, has enabled us to produce a machine which insures convenience, reliability and compactness. Every part is carefully proportioned, adjustments being provided for all wearing parts, and the material and workmanship are of the best. The pump requires but little head room, and every part is accessible for cleaning, adjusting and repairing. The connecting rods are of steel, having babbitted boxes with key adjustment on crank end, other end being solid with brass bushings. The plungers have outside stuffing-boxes, which can be readily packed, and being in sight, any leakage of water through the glands can be quickly detected. The pump cylinders are cast together, each being provided with a removable composition throat lining. All gears are cut, thus increasing smoothness of action and life of pump. Access to all valves is made easy by the removal of one large handhole-plate on valve chest. This type of machine is furnished with gear guards, as shown in cut. Suction hose and fittings will be furnished when specially ordered, at extra price.

FOR 300 FEET HEAD.

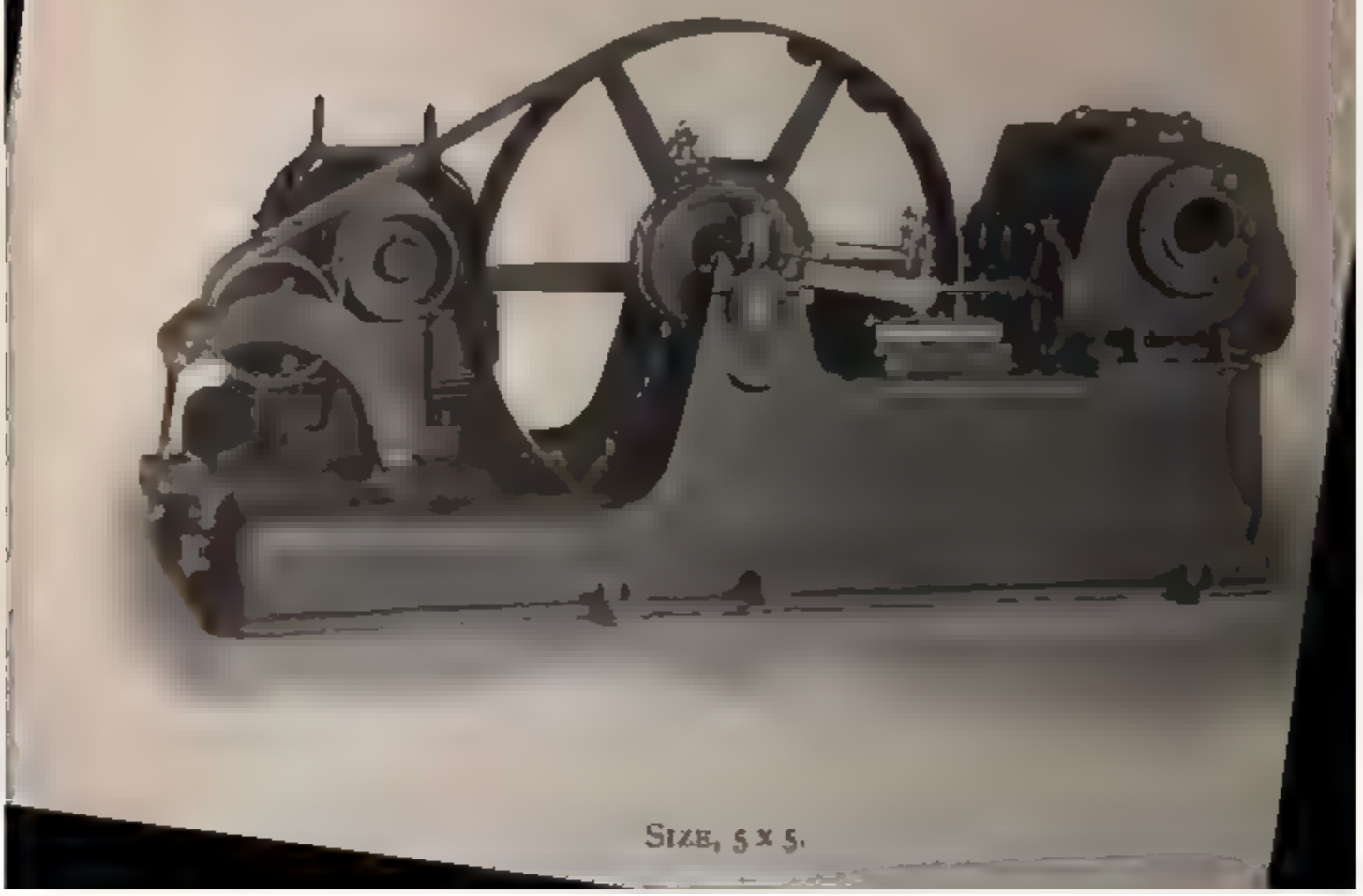
Diameter of Plungers.	Stroke.	Revolutions per Minute.	Gallons per Revolution.	Gallons per Minute.	Suction.	Discharge.	Ratio of Pump Gears.	Ratio of Motor Gears.	H. P. of Motor Required.	Gauge of Track in Inches.	Dimensions Over All. Height.	Dimensions Over All. Length.	Dimensions Over All. Width.	Telegraphic Code Word.
4	6	40	9792	30.15	2	2	3.5 to 1		5	24	3' 10"	7' 6"	3' 8"	Majadeamos
5	6	40	1.530	61.20	3	3	3.5 to 1	To Suit	7½	30	4' 0"	7' 8"	4' 2"	Majadearon
5	8	40	2.040	81.60	3	3	3.6 to 1	Speed	10	30	4' 0"	8' 2"	4' 2"	Majadoras
6½	8	40	3.446	137.92	4	4	4 to 1	of	15	41 to 43½	4' 1"	9' 4"	5' 4"	Majalibus
7	8	40	3.955	150.64	4	4	4 to 1	Motor.	20	43½ to 45	4' 5"	9' 8"	5' 8"	Majalium
8	8	40	5.222	208.88	5	4	4 to 1		25	43½ to 45	4' 9"	10' 0"	6' 0"	Majam

FOR 200 FEET HEAD.

8	8	58	5.222	302.87	6	5	4 to 1	To Suit	25	50	4' 9"	10' 0"	6' 5"	Majestades
9	8	62	6.609	409.75	7	6	4 to 1	Speed	35	72	5' 2"	10' 6"	8' 6"	Majestical
9	10	61	8.262	503.98	8	7	4 to 1	of Motor.	40	72	5' 6"	11' 0"	8' 6"	Majestorum

Knowles Horizontal Duplex "Centre-Inlet Power Air Pump.

Electric Pump (Close Belted). Double-Acting Piston Pattern.



Size, 5 x 5.

[redacted]

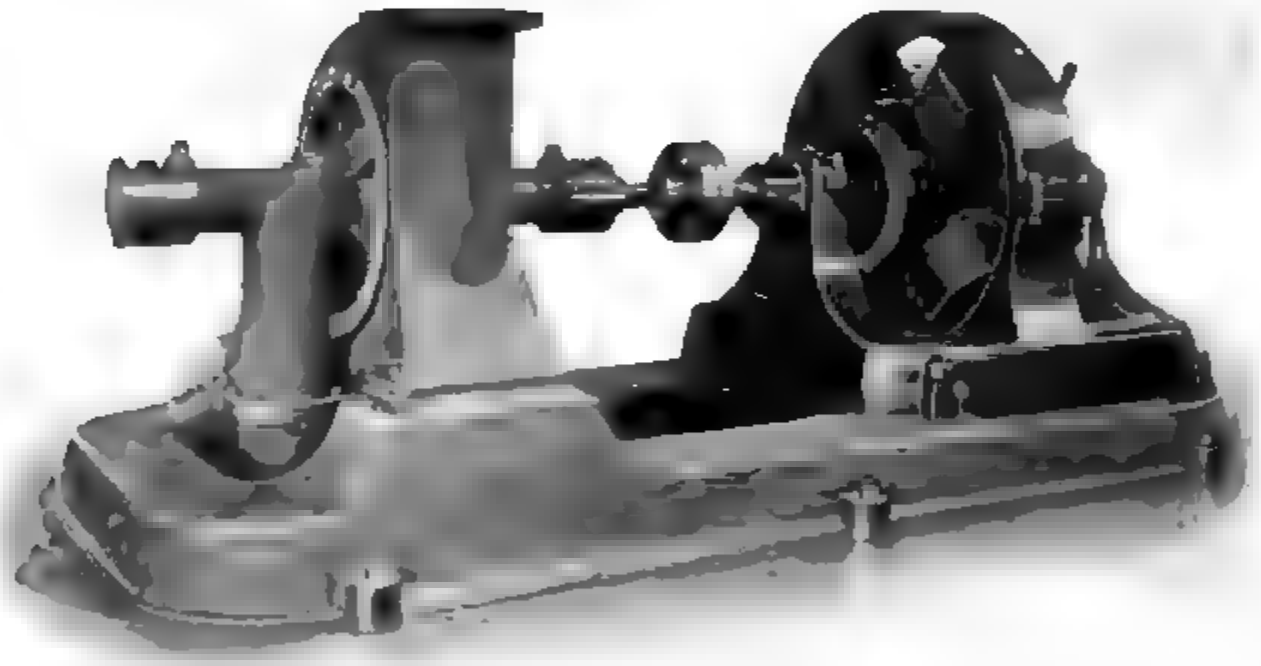
Knowles Horizontal Duplex "Centre-Inlet" Power Air Pump with Electric Motor.

Double-Acting Piston Pattern.

THE cut shown represents a 5 x 5 electrically driven power air pump, used in connection with steam-heating plants for large buildings, etc. This machine is very compact, self-contained, and well adapted for hard usage, being rigidly mounted on one large and heavy bed-piece. The running parts are well proportioned, specially designed for their particular service, adapted for high speed and have large wearing surfaces, with adjustments for taking up wear where necessary. By the use of our specially constructed belt tightener a large arc of belt contact is obtained on both motor pulley and driving wheel. The two air cylinders are cast together ; the pistons travelling by a single suction port, located centrally in each cylinder, does away with the necessity of suction valves and reduces the size and number of parts for the air end. At each end of each cylinder there is one large disk discharge valve, which slides on guides in line with the piston rods. This insures a free and direct means of taking care of large quantities of air, and is particularly adapted for the high speed and special service for which these machines are constructed. The machine as a whole is efficient, durable, and up-to-date in all respects.

Diameter of Pistons	Stroke	Revolutions per Minute.	Displacement, Both Pistons, per Minute, Cubic Feet	Suction.	Discharge.	H. P. Motor Required	Dimensions Over All			Telegraphic Code Word
							Height.	Length.	Width.	
4	4	300	18.2	4	3½	5	3' 11"	6' 2"	3' 6"	Maisonette
5	5	300	36.9	5	4	5	3' 0"	6' 4"	3' 6"	Maisonnage

Knowles
Centrifugal Pump with 20 H. P. Motor.

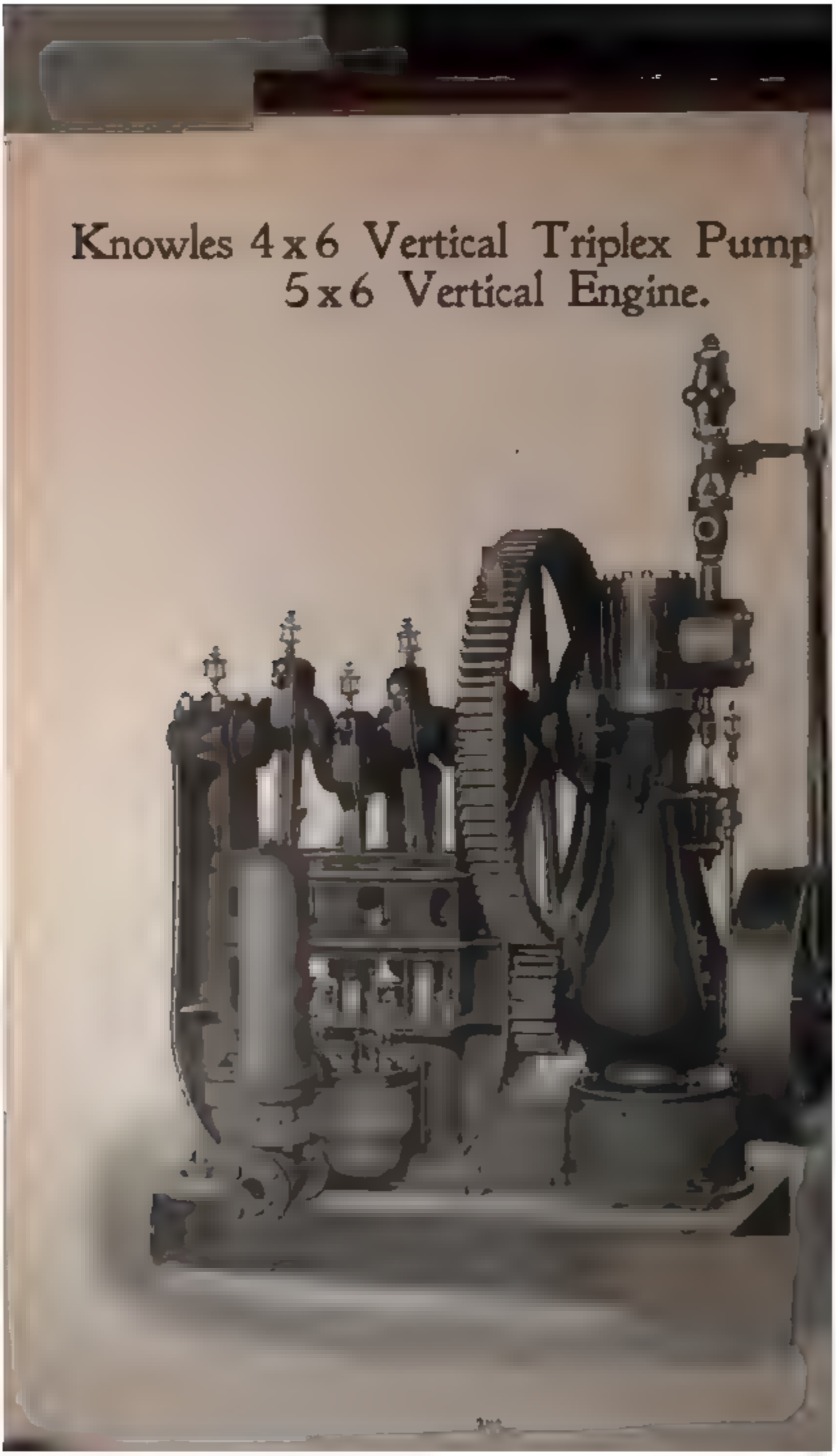


Capacity, 3000 gallons per minute.

Centrifugal Pump with Electric Motor Attached.

THE cut represents our Centrifugal Pump directly connected to a 20 horse-power motor, both located in a compact manner on a common base of rigid construction. The pump is of the double suction type, being made of bronze or cast-iron, as desired. It is so constructed that the water is taken on both sides of the pump case, so that an equal amount of water enters on each side of the fan, perfectly balancing it and preventing all end thrust of pump shaft, thus largely increasing the efficiency of the pump. This type has met with great favor in electric light stations and many other places, on account of its simplicity, durability, and great capacity. It will handle a large quantity of fluid of a muddy or gritty nature, pumping the same without injury to parts. The fan shaft runs in long, well-babbitted bearings, which are thoroughly water-sealed and readily accessible for adjustment. If the pump is overcrowded it is impossible to secure good results, and if too small for the work employed, will prove very expensive in power. The cost in power required to drive the small pump would be many times over the difference in cost for a larger pump, which would do the work economically. When the pump is to be used only temporarily the power may not be of consequence; then a smaller pump could be used than if intended for continuous work. Specifications will be furnished to suit conditions upon receipt of information.

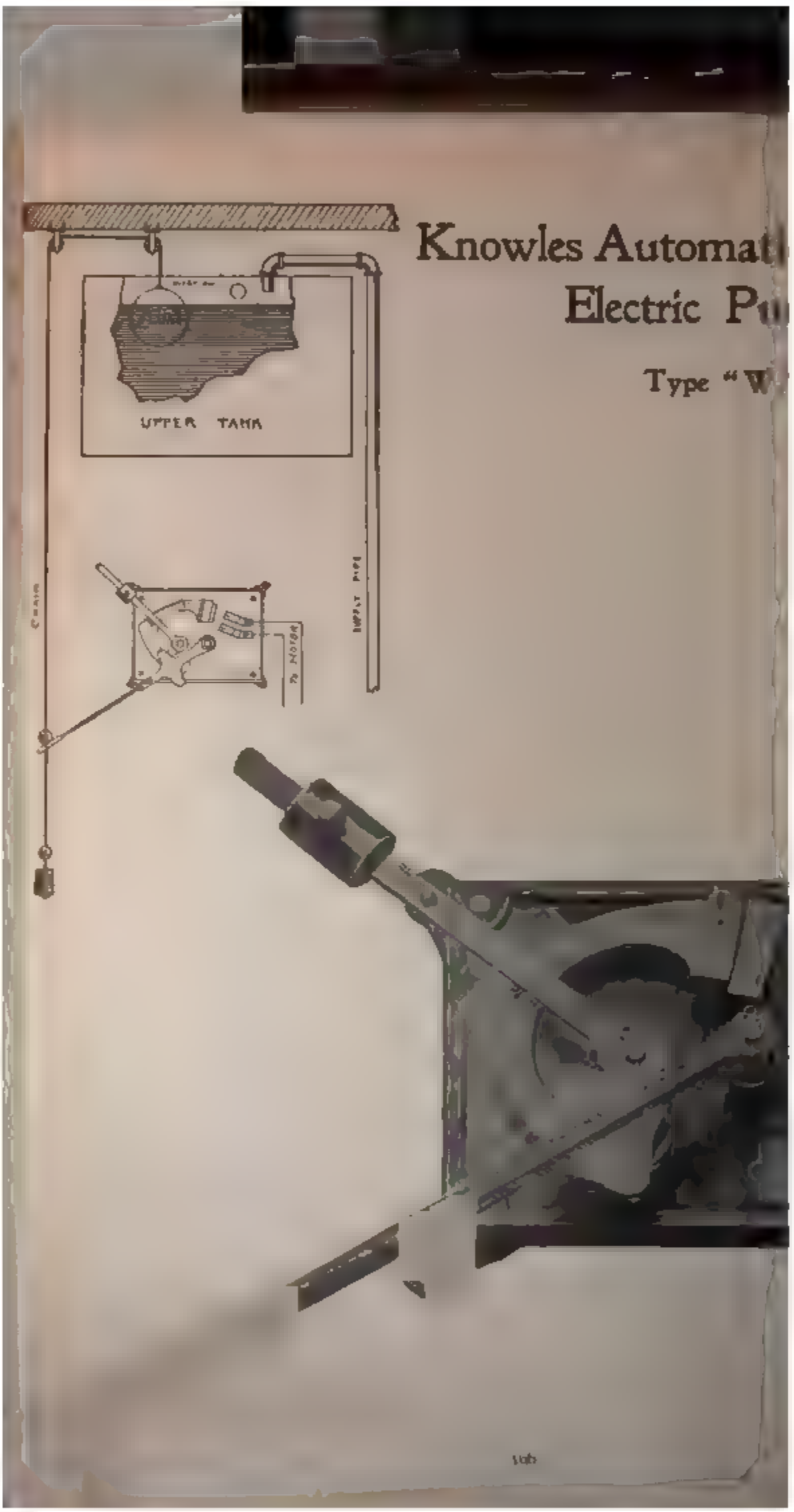
Knowles 4 x 6 Vertical Triplex Pump
5 x 6 Vertical Engine.



Knowles

4 x 6 Vertical Triplex Pump with 5 x 6 Vertical Engine.

THE cut represents our Vertical Triplex Pump, Style G, connected to its driving engine by heavy cast-iron cut gears, which insure quiet and even action and durability. Both engine and pump are of rigid construction, being designed for hard and continuous service. The driving engine is of improved construction, is economical and durable, and has all the refinements of take-up adjustments for wear peculiar to this type of machine. It is placed beside pump, securely bolted to a rigid base, both making a very compact machine. The pump itself is fully described in first part of catalogue in regard to regular fittings, but, in addition, this pump is provided with an outside lifting device for the suction valves, so that any or all valves may be raised from their seats while the pump is running. This arrangement takes the place of an ordinary "run round" pipe, and is used to regulate the amount of discharge water, within limits. The suction air chamber and tee, governor for engine, and lifting device for suction valves, are not furnished unless specially ordered, and then at an extra price. On account of varying conditions, we solicit correspondence regarding this type of machine.



Knowles Automat
Electric P

Type "W

Knowles Automatic Switches for Electric Pumps.

THE cut shows our type "W" Automatic Switch, adapted for use in starting from a distance small series wound motors. For light pump work this switch has been found to be most desirable. It is a single pole, low tension, direct current switch. The outline drawing at the left of cut indicates the manner of connecting the switch to the supply tank. When the water in the tank falls the float drops also, being connected by chain to operating arm on switch, causing the arm to rise, thereby completing the electric circuit, starting motor and pump to supply the tank again. When filling, the float rises with the water, and being balanced by a weight on the end of chain, the operating arm drops back at the proper time, stopping motor and pump. In this manner the tank is supplied automatically, the pump and motor needing but very little care.

Type "X," not illustrated, is for use where the double pole arrangement is preferred, being adapted for starting two and three phase motors, either direct or alternating current systems.

Type "Y," not illustrated, is double pole, adapted for starting motors on 500 or 600 volt power circuits and for multi-phase work, either direct or alternating current systems. The current-carrying parts are kept on opposite sides of the switch, thereby lessening the possibility of accidental short circuit. To prevent the possibility of drawing an arc on breaking the circuit, a wide break space is provided.

Adapted only for 1 Horse-Power and Smaller Motors.		Telegraphic Code Word.
Type "W," Maximum Volts, 300.	Maximum Amperes, 20	Maisfeld
Type "X," Maximum Volts, 300.	Maximum Amperes, 20	Maisfelder
Type "Y," Maximum Volts, 600.	Maximum Amperes, 15	Maisgelbes

Knowles
Automatic Motor Starter for Electric Pum

Type "Z."

Knowles Automatic Motor Starter.

For Electric Pumps Supplying Open Tanks.

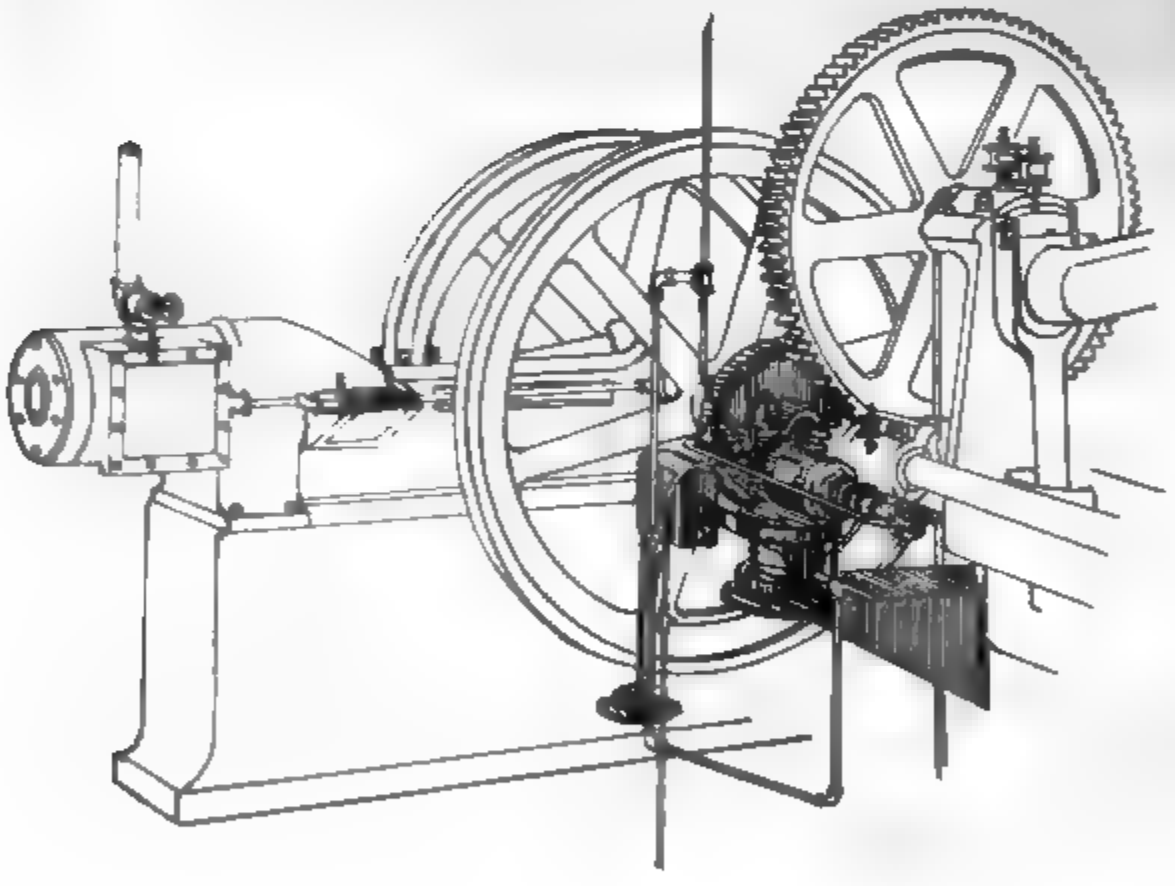
For Starting Shunt, Series, or Compound-Wound Direct-Current Motors.

TYPE "Z," here illustrated, is a very compact and complete piece of apparatus in itself. Some of the numerous points of construction are: The double-pole knife switch, automatic magnetic release, knife form rheostat contacts, long travel in the rheostat lever, and many other desirable features applicable to a device of this kind. Gravity is the only force employed in its operation, as springs and solenoids have demonstrated their unfitness for this purpose. By the interaction of a number of levers, actuated by suitably proportioned weights, the various operations are accomplished. The time taken to completely start the motor may be regulated by the adjusting screws located on the pivoted air dash-pot, and by moving the weight nearer to or further from the centre. One valuable feature of our starter is the ease with which all the working parts can be removed and the wearing parts renewed. This starter will be found desirable for all classes of work where automatic starting is desired, such as pump, elevator, crane, fan, organ, etc., etc. Larger than 25 horse-power starters will be furnished upon application. In sending inquiries or orders, always state whether motor is shunt, series or compound; otherwise, shunt will be understood. For series or compound-wound motors, state resistance of series coil.

H. P. of Motor.	Telegraphic Code Word.		
	Starter for 110-Volt Circuits.	Starter for 220-Volt Circuits.	Starter for 500-Volt Circuits.
½	Majolique	Majugena	Makemba
1	Majonnaise	Majuscule	Makerides
2	Majoration	Majusculum	Makhazan
3	Majorcan	Majuskel	Makheid
5	Majordame	Makable	Makheloth
7½	Majordomus	Makaire	Makis
10	Majoriario	Makakounan	Makistos
15	Majoribus	Makamen	Makkabaeer
20	Majorinos	Makarekau	Makkary
25	*Majorinum*	Makelaars	Makkelijk

Knowles
Automatic Clutch and Regulator.

FOR TRIPLEX POWER PUMPS.



Knowles Automatic Clutch and Regulator.

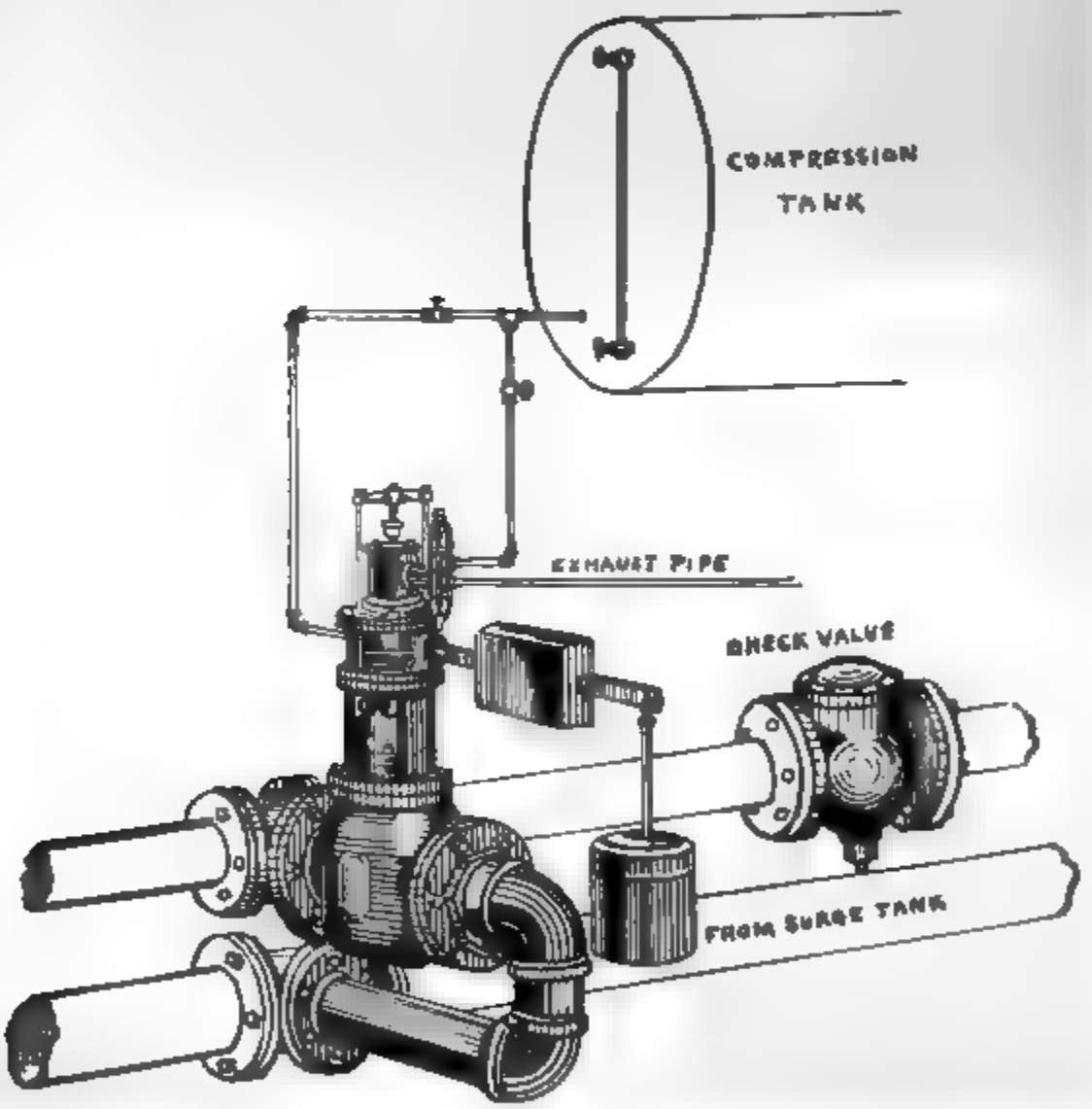
For Triplex Power Pumps.

often desirable to automatically control a power pump, that it may stand le when not needed, thereby saving power and wear and tear on the . By using the ingenious outfit illustrated by full line engraving, the is made to start and stop automatically, whether driven by gas or gaso- ngine or by steam engine. This can be used when pump is either direct cted, belted or driven by belt from line shaft. It is used only where pressure is available to operate the automatic clutch; and when an open compression tank is used, a nearly uniform water-level or pressure is ained. This device is so arranged that it may be connected to the clutch it the use of bell-cranks, levers, etc., and can be adjusted to operate at essure not over 150 pounds. On account of the various uses to which vice may be put it is necessary to know the conditions and requirements giving advice in regard to size, etc., to be used.

Size of Clutch.	Size of Pump.	Telegraphic Code Word.
8-inch	4 x 6 and 4½ x 6	Mairitt
10-inch	5 x 6 and 5 x 8	Maisaar
12-inch	5½ x 8, 6 x 8, and 6½ x 8	Maisacker
12-inch	7 x 8 and 8 x 8	Maisaehre
14-inch	8 x 10 and 8 x 12	Maisbau
16-inch	9 x 10 and 9 x 12	Maisbreies
18-inch	10 x 12	Maisbrot

Knowles
Automatic Regulator and By-pass.

FOR TRIPLEX POWER PUMPS.



Knowles Automatic Regulator and By-pass for Elevator or Other Service.

For Pumps Running Continuously.

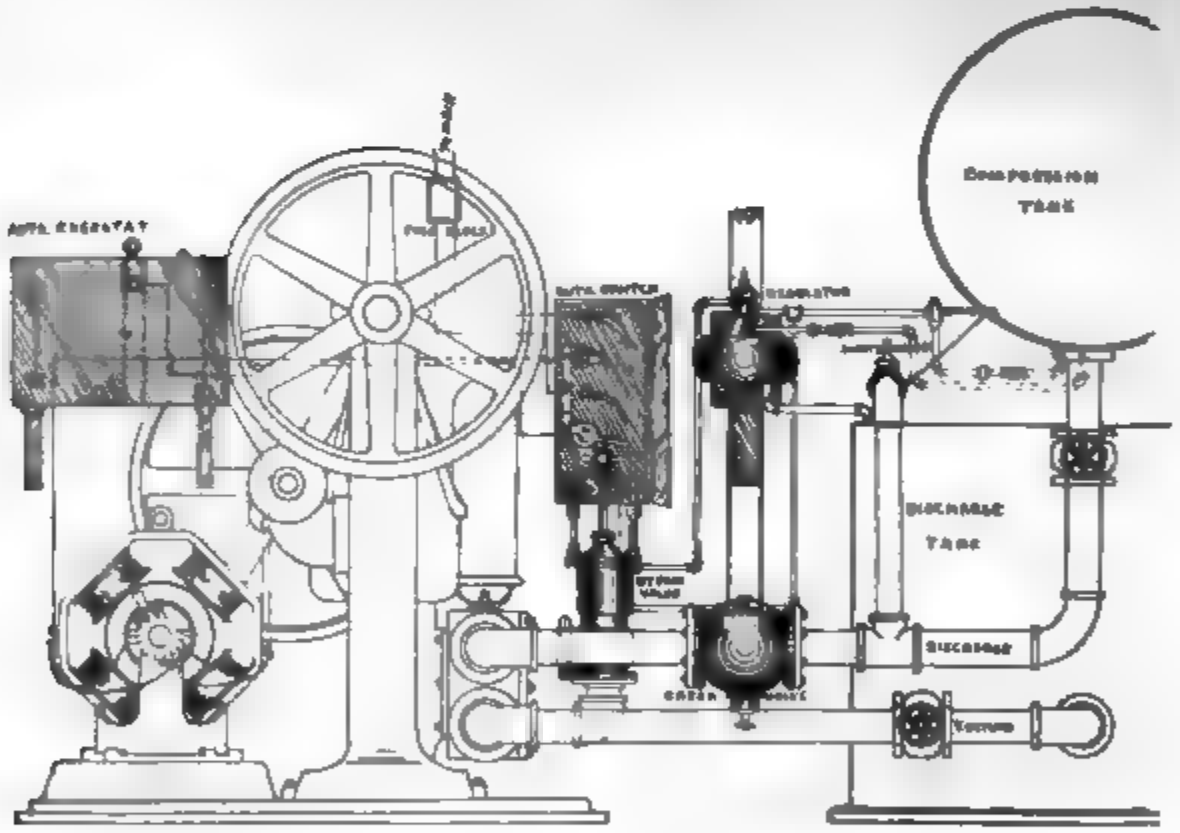
THE illustration shows our controlling device that we attach to continuous running pumps for elevator or other service, driven from a line shaft, motor, or any other power which has other work to perform and cannot constantly stopping and starting. By simply changing the manner of connecting the pressure and drip pipes, this device can be used either as a pressure regulator for steam pumps or as a by-pass for power pumps. When used in connection with a power pump the pressure in the compression tank controls the discharge pressure on the pump. The regulator is adjustable for various pressures up to 150 pounds, therefore it may be set to open the by-pass valve whenever the desired pressure is reached, and the by-pass is kept open until the pressure begins to drop. Then the by-pass closes and the pump discharges into the tank until the limit pressure is again reached. Our automatic check valve being placed a little beyond the by-pass valve prevents any back pressure from the tank during the time the by-pass is open, relieving the pump from all work. Very little power is required to drive the pump when the pressure is up to the limit in the tank, as the by-pass allows the discharge to flow back into the pump with very little pressure.

NOTE.—An ordinary water relief or safety valve depends upon the pressure on the pump to keep it open, and does not relieve the pump of its load, but simply allows the surplus pressure above what it is set for to pass off. Our by-pass valve is entirely different, as the main valve is held wide open by the pressure in the tank, and does not depend in any way upon the pressure on the pump.

To be Used with Single-Acting Pumps.	Valves and Connections.	Telegraphic Code Word.
5 x 6 and 5 x 8	1½-inch	Malacmee
5½ x 8, 6 x 8, and 6½ x 8	2-inch	Malacoderm
7 x 8, 8 x 8, and 8 x 10	2½-inch	Malacoide
9 x 10, 8 x 12, and 9 x 12	3-inch	Malacolite
10 x 12, 11 x 12, 12 x 12, and 13 x 12	4-inch	Malacology
Double-Acting Pumps.		
6½ x 8, 7 x 8, 6½ x 10, and 7 x 10	3-inch	Malaconote
7 x 12, 8 x 12, 9 x 12, and 10 x 12	4-inch	Malacra
11 x 12 and 12 x 12	5-inch	Malactico

Knowles Automatic Start and Stop Control Complete.

FOR ELECTRICALLY DRIVEN PUMPS.



Knowles Automatic Start and Stop Controller Complete.

For Electrically Driven Pumps.

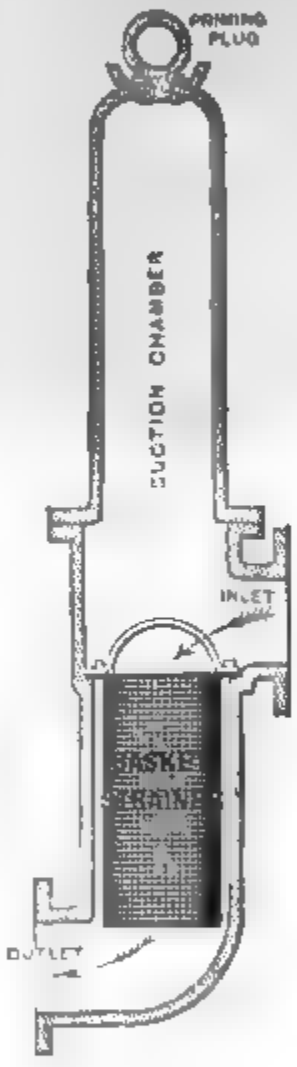
THE illustration shows pump and motor in connection with the several parts essential to make this device complete. The different parts are easily located, the name of each being given. The pressure in the compression tank entirely controls the pump and motor. When the limit pressure is reached, the regulator, being set for this pressure, causes the by-pass valve to open, thereby shutting off the current and stopping motor and pump. When the pressure drops, the regulator closes the by-pass valve, thereby turning the current on and starting motor and pump again. The motor and pump being at rest when the pressure is up, does away with the expense of current, and wear and tear on the pump. Our patent automatic check valve prevents any back pressure from the tank while the by-pass valve is open. The conditions and requirements should be fully stated, when sending inquires or orders, in order to furnish the parts shown by full line engraving to suit.

To be Used with Motors.	Telegraphic Code Word. For Start and Stop Controller.
10 Horse-Power.	Malagasy
15 Horse-Power.	Malagawein
20 Horse-Power.	Malagevole
25 Horse-Power.	Malagmata
30 Horse-Power.	Malagmatis
40 Horse-Power.	Malagmatum
50 Horse-Power.	Malagueiro

THE KNOWLES

"SIDE PIPE AND STRAINER."

WITH AND WITHOUT SUCTION CHAMBER ATTACHED.



IT IS always very desirable to place an efficient strainer on the suction pipe of a pump where there is any suspicion that the water contains dirt or sediment. We recommend the Knowles "side pipe and strainer," with or without suction chamber attached, as shown by engraving, which should always be placed close to the pump. The strainer basket inside can be readily taken out and cleaned. This arrangement is a great improvement on the method commonly practiced in putting strainers on the end of the suction pipe, where it is more or less inconvenient to get at to clean or repair. Should it be necessary to charge the pump with water as is often the case with long suction pipes, the priming plug shown at top of suction chamber can be easily removed. For plain strainers, see next page.

Sizes

Size of Suction Pipe . . Inches	2	2½	3	3½	4	5	6	8	10	12	14
Code Word, with Suction Chamber	a	b	c	d	e	f	g	h	i	j	u
Code Word, without Suction Chamber . .	k	l	m	n	o	p	q	r	s	t	w

a. Entwist	f. Envious	k. Eocene	p. Epaulet	u. Ephoral
b. Envassal	g. Environ	l. Eolian	q. Epenetic	v. Ephorally
c. Envenom	h. Envoy	m. Eolipsile	r. Epergne	w. Ephoromata
d. Enviable	i. Envying	n. Epanodos	s. Ephemera	x. Ephoros
e. *Envied*	j. Enwheel	o. Eparch	t. Ephod	

For Plain Suction Strainers, etc., see next page.

[redacted]

Check Valves and Foot Valves

These valves are made with flanged ends, as shown, or with screwed ends, at same price. When desired, they can be made with bell and spigot ends at a slight additional cost.

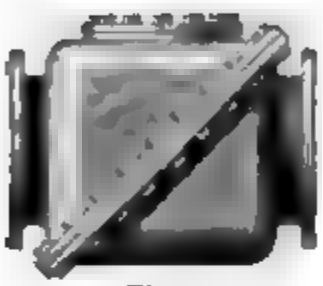


Fig. 1

Fig. 2

Size . . . . . Inches	2	2½	3	3½	4	5	6	8	10	12	14	16	18	20
Check Valve, Fig 1, Code Word	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Foot Valve, Fig. 2, Code Word	15	16	17	18	19	20	21	22	23	24	25	26	27	28

Strainers

Fig. 3

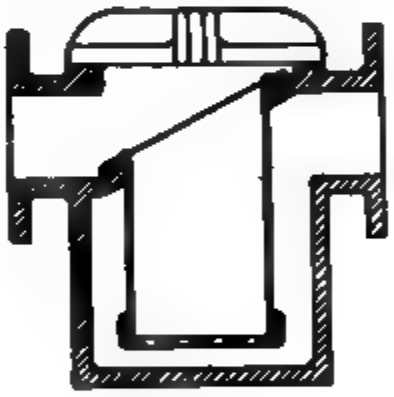


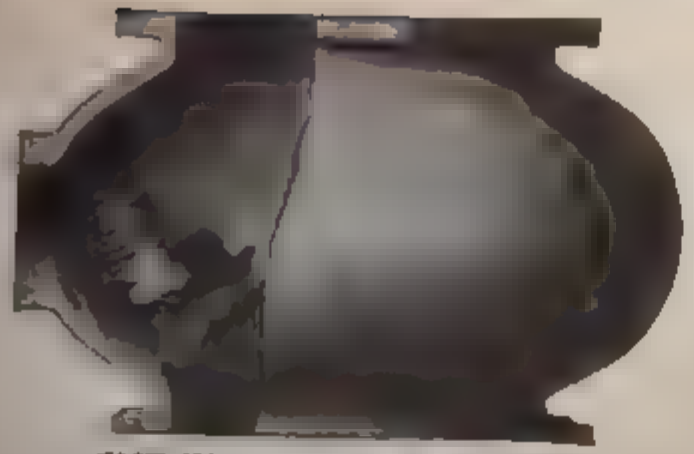
Fig. 4.

Fig 5

Sizes . . . . . Inches	2	2½	3	3½	4	5	6	8	10	12	14	16
Plain Strainer, Fig. 3, Code Word .	29	30	31	32	33	34	35	36	37	38	39	—
Basket Strainer, Fig. 4, Code Word .	40	41	42	43	44	45	46	47	48	49	50	62
Strainer and Foot Valve, combined, Fig. 5, Code Word	51	52	53	54	55	56	57	58	59	60	61	—

1 Epicarp
2. Epicede
3. Epicure
4. Epidemic
5 Epidemy
6. Epidictic
7 Epidote
8 Epigene
9 Epigeous
10. Epigram
11. Epigraph
12 Epilepsy
13 Epilogue
14 Epiphany
15. Epiphora
16. Epiphyte
17 Epiploce
18 Episcopy
19. Episode
20. Episodic
21 Episperm
22 Epistle
23 Epitaph
24. Epithet
25 Epitome
26 Epitrite
27 Epitrope
28. Epizoan
29 Epoch
30. Epode
31. Epulary
32 Epulose
33 Epulotic
34 Equable
35 Equant
36. Equation
37 Equator
38 Equerry
39 Equiform
40 Equine
41. Equinox
42. Equipage
43 Equipped
44 Equitant
45 Equity
46 Equivoke
47 Erasable
48. Erase
49. Erasing
50. Erasion
51 Erasure
52. Erbium
53 Erebus
54 Eremite
55 Ereption
56. Erethism
57. Ergot
58. Ergotism
59. Eridanus
60 Erinite
61. Erinnys
62. Eriocyon

CHECK AND FOOT VALVES.



CHECK VALVE 8 and over.

FOOT VALVE- 12" and over.

STRAINER-BOX AND STRAINER.

Strainer-Box and Strainer.

It is often necessary, and generally desirable, that there should be a strainer attached somewhere to the supply pipe of a pump. The difficulty of reaching it in case it should become obstructed and require cleaning, is the great objection to placing it on the end of the supply pipe furthest from the pump, and has led to the design and adoption of the arrangement shown in the illustration opposite.

As will be seen by an examination of the illustration, the strainer consists of a cylindrical casting with removable cover having nozzles which permit its being placed in the horizontal part of the suction pipe, forming a section of the same. The strainer proper consists of two cast brass grated plates which rest in vertical grooves, being so placed as to give the maximum area and offer the least resistance to the flow of the water. The plates can be readily removed and cleaned.

This strainer can in some cases be connected direct to the suction flange of the pump, but in order not to interfere with the removal of water cylinder heads it is recommended that a section of pipe or spool piece be interposed between the strainer and the pump.

Special strainers of larger sizes than those included in the list can be furnished.

Diameter of Suction Pipe.	Diameter of Flanges.	Distance Face to Face.	Dimensions of Box.		Telegraphic Code Word.
			Width.	Height.	
1½	Screwed	7	6	5½	Malignando
2	Screwed	9	7½	6½	Malignassi
3	7½	11	9	8	Malignato
4	8½	16½	11	9	Malignava
5	9½	17½	12	12	Maligned
6	10½	19½	14	14½	Malignerai
8	13	22	17	18	Malignify
10	15	28	21	22½	Maligning
12	17½	32	24	28	Malignly
14	19½	45	22	23½	Maligno

Check and Foot Valves.

These patterns are constructed with especial care as to proper proportion and strength, combined with good material and workmanship. The areas of their passages are sufficiently large to admit of the fluid passing through them with the minimum amount of frictional resistance.

The interior of the Check Valves can be reached by means of convenient hand-holes.

For the larger sizes of Foot Valves is provided an attachment, shown in the illustration on the opposite page, designed to relieve the valve and the supply pipe of any undue internal pressure to which they might be subjected. This is, in many cases, a very necessary safeguard, as with pumping machinery working under severe resistances, the water pressure can be transmitted through leakages from the force to the supply main, while the engine is at rest, and is generally sufficient to burst the foot valve or the suction chamber of the pump if they are not relieved through a safety device of this character.

The following list comprises the regular patterns of valves. They are usually kept in stock, and can always be furnished at short notice.

Check Valves.				Foot Valves.			
Size in Inches.	Telegraphic Code Word.	Size in Inches.	Telegraphic Code Word.	Size in Inches.	Telegraphic Code Word.	Size in Inches.	Telegraphic Code Word.
2½	Maliloquos	12	Malinorum	2½	Malitorne	12	Malleidae
3	Maliloquum	14	Malinteso	3	Malizietta	14	Mallejan
4	Malimbe	16	Maliques	4	Malkaar	16	Mallemock
5	Malinche	18	Malissimo	5	Malkruid	18	Mallemolle
6	Malinello	20	Malitatem	6	Mallard	20	Malleolus
7	Malinger	24	Malitatis	7	Mallaspis	24	Mallepost
8	Malingerer	30	Malitiosa	8	Malleating	30	Mallepraat
10	Malingreux	36	Malitiosum	10	Malleatori	36	Malletier

Unless otherwise ordered, these valves have flanges faced and drilled according to uniform standards. It should be stated, in ordering, if they are to be left blank, or are to be drilled to fit any special connection.

They can all be made with bell and spigot ends if desired, at somewhat increased cost.

Suction Air Chambers and Tees.

THE value of a suction air chamber is almost always overlooked by purchasers of pumps, they begrudging the room necessary for a properly arranged suction air chamber. It is also very important in the case of long suction pipes, but judgment must be used in placing them. The nearer the suction chamber is to the pump the better, and it should be placed in a direct line with the current, but if the foundation will not allow of the arrangement shown by sectional drawing, the chamber may be placed on the opposite side of cylinder from the suction opening with elbow in place of tee when cylinder construction will admit of this arrangement. A smoother running, less noisy and more efficient pump is the result of using a suction air chamber, because it not only relieves the shock of the water column against the water pistons and valves at each stroke, but it also allows the head of water (if any) on the suction to be fully utilized.

Size.	Telegraphic Code Word.	
	For Air Chamber.	For Tee.
3"	Malambo	Malares
4"	Malamuris	Malarial
5"	Malandanca	Malarious
6"	Malandato	Malarmot
8"	Malandera	Malascaras
10"	Malandriae	Malasanda
12"	Malapari	Malassammo
14"	Malapecora	Malassando
16"	Malapertly	

[redacted]

When Ordering Parts

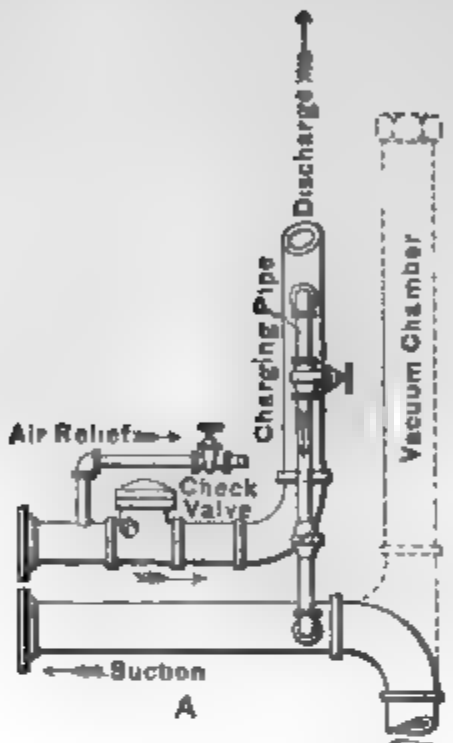
)WING TO the fact of our having constructed pumps of the same size for different duties, and also on account of the improvements which e have made from time to time, during our long business career, it is BSOLUTELY NECESSARY that all orders for parts should be accompanied ith the MANUFACTURER'S SERIAL NUMBER of the pump for which said arts are required.

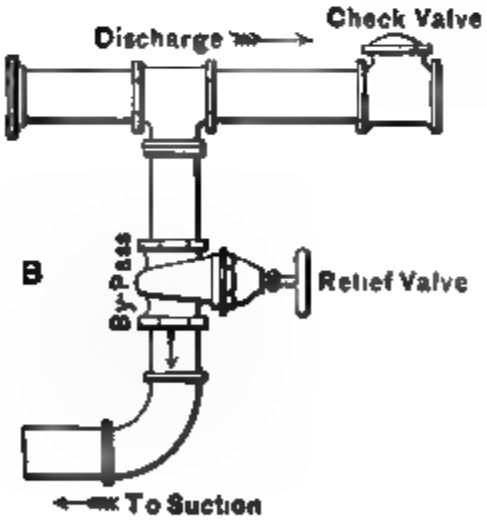
This number will be found stamped in some conspicuous position on very pump made by us. In the case of the triplex power pumps, there is number plate which is always placed on the frame, and the SERIAL NUMBER s also stamped on the end of the crank shaft. On single and duplex power umps, horizontal pattern, the number is always stamped on the crank pin nd on the connecting rod strap; also on the outside flange of the water ylinder head. There is also a number plate placed generally on the ame, although sometimes it is placed on the water cylinder on the inside id. On air compressors the number is stamped on the edge of the flange the cylinder, also on the edge of the cylinder head; and there is also a mber plate placed on the centre piece.

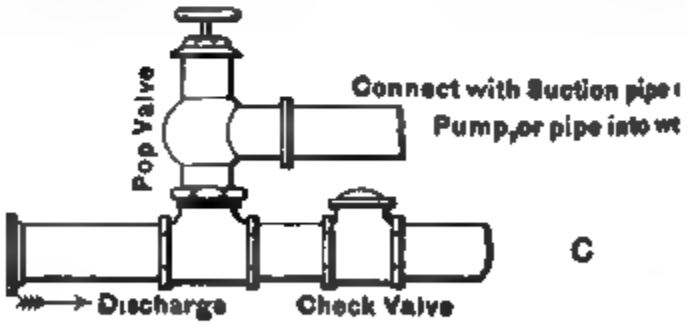
As we manufacture every part to gauge, and have a complete record of pumps built by us, we can send correct duplicate pieces on receipt of ove information. Without manufacturer's number we CANNOT duplicate rts with certainty.

If the MANUFACTURER'S SERIAL NUMBER has become covered with rust, rt or paint, take a file or a piece of emery cloth and rub at the point dicated above. This will bring out the MANUFACTURER'S NUMBER so that can be easily read.

KNOWLES STEAM PUMP WORKS.







Plan of Piping for Knowles Power Pumps

ıggestions When Erecting and Operating Knowles Power Pumps

FOUNDATION — In all of the small sizes of our pumps sufficient ındation is afforded by a good plank floor, such as is found in any well nstructed factory. For heavier pumps a more solid foundation should used, such as brick, stone, or well rammed concrete, surmounted by a p stone. Anchor bolts should be used in all cases.

Although our power pumps are self-contained, and not dependent upon undation to preserve alignment of working parts, yet a good foundation eserves proper relative position of pump in regard to driving mechanism, ıd lessens strain and jar in piping.

That no delay may occur in setting the pump upon arrival, drawings ıowing location of bolt holes, flanges, and general dimensions will be sent ɔon receipt of order, when desired.

SUCTION PIPE — Use as short and direct suction pipe as possible. se as few elbows as practicable; and in cases where the suction is long ıd several elbows occur, increase size of suction pipe. Never use naller sizes than pump openings call for.

A vacuum chamber should be used in all cases of long suction pipe or ıgh lift. This chamber may be made of pipe, as shown in sketch A; a olume of two per cent. of the pump capacity per minute giving good esults.

A foot valve, with strainer attached, should be placed at the end of ıe suction pipe. See illustration A.

A light suction is an advantage, except in the case of pumping hot ater; then the water should go to the pump under a slight head.

Be sure there are no leaks in the suction pipe.

Dra[illegible]pe — Using as straight discharge pipe as possible, with long ben[illegible]e valves, increases the efficiency of the pump. A check valve should be placed in the discharge pipe, as sketches A, B, and C show.

To Insure Immediate Action upon Starting up When a pump takes suction under difficult conditions, and air is present in the suction pipe and the pump, a charging pipe should be connected, as shown in sketch A. This charging pipe runs from a point in the discharge pipe, beyond the check valve, to suction pipe, and is provided with a gate valve. An air relief pipe is also inserted in the discharge pipe between the pump and check valve, also shown in sketch.

On starting the pump, open the valve in the charging pipe, and also in the relief pipe. Water thus flows from the reservoir or tank to the suction pipe, dispelling air through the relief pipe.

Any slight leakage from the plungers and glands should be piped to a drain.

When a power pump is used for boiler-feeding, it is run at a constant speed, calculated to give the maximum supply of water required at any time. This supply required varies, and rather than shut down the pump a by-pass between the discharge and the suction pipe is inserted, as sketch B shows The water can thus be fed continuously to the boiler, and intermittent feeding, which involves loss of heat to feed water as well as destructive influence to pump, can be avoided.

Overloading, causing high pressure and consequent injury, should be guarded against in every power pump. This is provided for by placing an automatic water relief valve, connected to the discharge pipe, close to the pump. (See sketch C, "pop" valve.) This valve should be set to open at a pressure well within the limits of the strength of the pump When several boilers are fed by the same pump, this automatic relief valve is placed in the by-pass mentioned above and shown in sketch B. It is set to open at a slightly higher pressure than that carried on *the boiler.* The surplus feed water passes through this valve to the

ction pipe or well, and the supply to each boiler is regulated by its op valve.

Remember in all piping that a slightly longer pipe does not increase e friction nearly so rapidly as an elbow.

PACKING.— All stuffing boxes should be carefully packed, and glands rought up firmly against the packing; screwing up glands by hand ould be sufficient, especially where hot water is used, which swells the acking.

Owing to improper adjustment of packing in pumps, feeding hot ater to boilers under high pressure, it is often difficult to keep them tight. packing to be good, should have a strong fibre, be well lubricated, and such construction that slight pressure of the gland will cause it to hug e plunger.

A few new layers are often sufficient in repacking a pump; but old acking should be removed as soon as it becomes hard, otherwise it will t the plungers.

Useful Information

Fire Streams

Work done by and Power Required for Fire Streams, using Rubber Hose and 1⅛ inch Smooth Nozzle.

G. A. Ellis, C. E., and A. P. Leshore.

Effective Pressure at Nozzle	Gallons Discharged in One Minute	Horizontal Distance Reached by Jet	Vertical Distance Reached by Jet	Pressure in Pounds Required at Hydrant or Pump to Maintain Given Effective Pressure at Nozzle With Different Lengths of Hose										Effective Pressure at Nozzle
				100 feet	200 feet	300 feet	400 feet	500 feet	600 feet	700 feet	800 feet	900 feet	1000 feet	
10	98	49	22	14	17	21	24	28	31	35	38	42	45	10
15	120	60	33	20	25	30	35	41	46	51	56	61	66	15
20	139	71	43	27	34	40	47	54	60	68	74	81	88	20
25	155	82	53	33	42	50	59	67	76	84	92	101	109	25
30	170	93	63	40	50	60	71	81	91	101	111	121	132	30
35	183	103	72	47	59	70	82	94	106	118	129	141	153	35
40	196	113	81	54	67	81	94	108	121	135	149	162	176	40
43	203	119	86	58	72	87	101	116	131	145	160	174	189	43
46	210	125	91	62	77	93	109	124	140	156	171	187	202	46
49	216	130	95	66	82	99	115	132	149	165	182	198	215	49
52	223	135	100	70	87	105	123	140	158	176	193	211	229	52
55	230	140	105	74	93	112	130	149	168	186	205	224	243	55
58	236	145	109	78	98	118	138	157	177	197	217	237	257	58
61	242	150	114	82	103	124	145	166	187	208	229	249	270	61
64	248	154	118	86	108	130	152	174	196	218	240	262		64
67	253	159	122	90	113	136	159	182	205	228	251	274		67
70	259	163	125	94	118	142	166	191	215	239	263			70
72	263	165	128	97	122	146	171	196	221	246				72
74	266	168	130	99	125	150	176	201	227	252				74
76	270	170	133	102	129	155	181	207	233					76
78	273	173	135	105	132	159	186	212	259					78
80	277	175	137	108	135	163	191	218	246					80
82	280	178	139	110	139	167	195	224						82
85	285	181	143	114	144	173	203	232						85
88	290	184	146	118	149	179	210							88
91	295	186	149	123	154	186	217							91
94	300	188	152	127	159	192	225							94
97	305	191	154	131	165	198								97
100	310	193	157	135	170	205								100

Water

DOUBLING THE diameter of a pipe increases its capacity four times [illegible] Friction of [illegible] increases as the square of the velocity. The mean pressure of the [illegible] sphere [illegible] [illegible] pounds to the square inch, so that with a perfect vacuum it [illegible] sustain [illegible] [illegible] of water 33.9 feet high.

[illegible] IN POUNDS TO THE SQUARE I[illegible] [illegible]imately, we say that eve[illegible] [illegible] for ordinary friction.

[redacted]

To Find the Diameter of a Pump Cylinder to move a given quantity of water in a minute (100 feet being the standard of speed), divide the number of gallons by 4, then extract the square root, and the product will be the diameter in inches of the pump cylinder

To Find Quantity of Water elevated in one minute, running at 100 feet of piston speed in a minute. Square the diameter of the water cylinder in inches, and multiply by 4. Example: Capacity of a 5 inch Cylinder is desired. The square of the diameter (5 inches) is 25, which, multiplied by 4, gives 100, the number of gallons in a minute (approximately)

To Find the Horse Power necessary to elevate water to a given height, multiply the total weight of the water in pounds by the height in feet, and divide the product by 33,000 (an allowance of 25 per centum should be added for water friction, and a further allowance of 25 per centum for loss in steam cylinder)

The Area of the Steam Piston, multiplied by the steam pressure, gives the total amount of pressure that can be exerted. **The Area of the Water Piston**, multiplied by the pressure of water to the square inch, gives the resistance. A **Margin** must be made between the **Power** and the **Resistance** to **Move** the pistons at the required speed — say from 20 to 40 per centum, according to speed and other conditions

To Find the Capacity of a Cylinder in gallons. Multiplying the area in inches by the length of stroke in inches will give the total number of cubic inches; divide this amount by 231 (which is the cubical contents of a United States gallon in inches), and product is the capacity in gallons.

Cast-iron Pipe

Safe thickness of Metal and Weight of a Length, including Bells, for different sizes and under various heads of water

Sizes Inside Diameters	25 ft. Head or 10.82 Pounds Pressure		50 ft Head or 21.65 Pounds Pressure		100 ft Head or 43.30 Pounds Pressure		150 ft Head or 64.85 Pounds Pressure		200 ft Head or 86.60 Pounds Pressure		250 ft Head or 108.25 Pounds Pressure		300 ft. Head or 129.90 Pounds Pressure		Contents in Gallons for 1 ft in Length
	Thickness of Metal	Weight of a Length	Thickness of Metal	Weight of a Length	Thickness of Metal	Weight of a Length	Thickness of Metal	Weight of a Length	Thickness of Metal	Weight of a Length	Thickness of Metal	Weight of a Length	Thickness of Metal	Weight of a Length	
2	.255	54	.294	63	312	67½	330	72	348	76½	366	81	.384	86	163
3	.330	132	.344	144	353	749	362	853	371	157	380	161	390	166	.367
4	.335	280	.361	197	373	204	385	211	397	218	409	226	.42[illegible]	235	.652
6	.375	300	.393	315	.411	330	.429	345	447	361	465	377	.483	393	1 469
8	.433	456	.442	445	.450	475	.474	502	498	529	522	557	.54[illegible]	584	2 611
10	.442	576	.459	600	489	641	519	682	549	723	579	766	.609	805	4 081
12	.446	720	.491	768	.527	826	563	885	5[illegible]9	944	[illegible]35	1004	.671	1064	5 876
14	. .	.	524	952	566	2031	.608	1111	.650	1191	692	1272	734	1352	7 917
16	. .		.580	1215	.604	1353	.652	1360	700	1463	748	1568	796	1673	10 44
18		.	589	1370	.643	1500	697	1630	751	1761	805	1884	859	2026	13 22
20		.	.622	1603	682	1763	742	1924	802	2086	862	2248	.922	2412	16 32
24	.	.	.687	2120	.759	2349	831	2580	.903	2811	975	3045	1 047	3279	23 50
30		.	.785	3020	.875	3376	965	3735	1 055	4095	1 145	4458	1 235	4822	36 72
36	. .	. .	882	4070	996	4581	1.098	5096	1.206	5623	1 314	6153	1 422	6686	52 88
48	.	. .	1.078	6616	1.222	7531	1 366	8431	1 510	9340	1 654	10269	1 798	11195	94.02

All pipe cast in lengths of 12 feet, except the 2 inches, which are cast 9 feet long
Pipes with flanges weigh about 15 per centum more than above.
Packing of Rubber for flanged pipe is usually ⅛ inch thick, and weighs about 1[illegible] pounds to the square yard.

Weight and Capacity of Different Standard Gallons of Water.

	Cubic Inches in a Gallon	Weight of a Gallon in Pounds	Gallons in a Cubic Foot	Weight of a cubic foot of water, English standard, 62.321 lbs. Avoirdupois
Imperial or English .	277.274	10.00	6.232102	
United States	231	8.33[illegible]	7.480519	

Weight of Crude Petroleum, 6⅝ lbs. per United States gallon } 42 gallons to the barrel.
Weight of Refined Petroleum, 6½ lbs. per United States gallon }
A "miner's inch" of water is approximately equal to a supply of 12 United States gallons per minute.

Table of Capacity of Pumps

The figures at the extreme right and left of the table are piston, or plunger, diameters; the line of figures across the top are piston, or plunger, ...; the figures in the body of the table are the capacity, or displacement, in gallons, corresponding to a single stroke. To find the capacity ... revolution, multiply the capacity for a single stroke by one, two, or three, for single, duplex, or triplex single-acting pumps, and by two, ... six, for double-acting pumps.

Table Showing Capacity of Pumps of Given Diameter and Length of Stroke

Dia. of Cyl. Ins.	Length of Stroke in Inches, and Capacity per Stroke in Gallons of Pump Cylinder, with Given Diameter																Dia. of Cyl. Ins.
	2	3	4	5	6	7	8	9	10	12	14	15	16	18	20	24	
1¼	.0106	.0159	.0212	.0266	.03	.0372	.0425	.0478	.0531	.0637	.0743	.0797	.0849	.0955	.1062	.1274	1¼
1⅜	.0128	.0192	.0256	.0321	.0385	.0449	.0513	.0578	.0642	.077	.089	.0963	.1027	.1156	.1284	.1541	1⅜
1½	.0153	.0229	.0306	.0382	.0459	.0535	.0612	.0688	.0765	.0918	.1071	.1147	.1224	.1377	.1530	.1836	1½
1¾	.0208	.0312	.0416	.0521	.0625	.0729	.0833	.0937	.1041	.1249	.1457	.1562	.1666	.1874	.2082	.2499	1¾
2	.0272	.0408	.0544	.068	.0816	.0952	.1088	.1224	.136	.1632	.1904	.204	.2176	.2448	.2720	.3264	2
2¼	.0344	.0516	.0688	.086	.1033	.1205	.1377	.1548	.1721	.2063	.241	.258	.2754	.3096	.3442	.4128	2¼
2⅜	.0425	.0637	.085	.1062	.1275	.1487	.17	.1912	.2125	.255	.2975	.3187	.34	.3825	.425	.51	2⅜
2¾	.0514	.0771	.1028	.1285	.1543	.1799	.2057	.2313	.2571	.3085	.3598	.3855	.4114	.4626	.5142	.617	2¾
3	.0612	.0918	.1224	.1530	.1836	.2142	.2448	.2754	.306	.3672	.4284	.459	.4896	.5508	.612	.7344	3
3¼	.0718	.1077	.1436	.1795	.2154	.2513	.2872	.3231	.3594	.4312	.503	.5385	.5748	.6466	.7182	.8624	3¼
3½	.0833	.1249	.1666	.2082	.2499	.2915	.3332	.3748	.4165	.4998	.5831	.6247	.6664	.7497	.833	.9996	3½
3¾	.0956	.1434	.1912	.239	.2868	.3346	.3824	.4302	.478	.5736	.6692	.687	.7648	.8605	.9561	1.147	3¾
4	.1088	.1632	.2176	.272	.3264	.3808	.4352	.4896	.544	.6528	.7616	.816	.8704	.9792	1.088	1.3056	4
4¼	.1228	.1842	.2456	.307	.3684	.4298	.4912	.5526	.6141	.7368	.8596	.921	.9824	1.105	1.228	1.473	4¼
4½	.1377	.2065	.2754	.3442	.4131	.4819	.5508	.6196	.6885	.8262	.9639	1.0327	1.1016	1.2393	1.377	1.6524	4½
4¾	.1534	.2301	.3068	.3835	.4602	.5369	.6136	.6903	.7671	.9204	1.073	1.15	1.227	1.38	1.534	1.84	4¾
5	.17	.2550	.34	.425	.51	.595	.68	.765	.85	1.02	1.19	1.275	1.36	1.53	1.7	2.04	5
5¼	.1874	.2811	.3748	.4685	.5622	.6559	.7496	.8433	.9371	1.124	1.311	1.405	1.499	1.686	1.874	2.248	5¼
5½	.2057	.3085	.4114	.5142	.6171	.7199	.8228	.9256	1.0285	1.2342	1.4399	1.5427	1.6456	1.8513	2.057	2.4684	5½
5¾	.2248	.3372	.4496	.562	.6744	.7868	.8992	1.011	1.124	1.348	1.573	1.686	1.789	2.022	2.248	2.696	5¾
6	.2448	.3672	.4896	.612	.7344	.8568	.9792	1.1016	1.2240	1.4688	1.7136	1.8362	1.9584	2.2032	2.448	2.9376	6
6¼	.2656	.3984	.5312	.6640	.7968	.9296	1.062	1.195	1.328	1.593	1.859	1.992	2.124	2.39	2.656	3.180	6¼
6½	.2872	.4308	.5744	.7182	.8616	1.0052	1.1488	1.2926	1.4364	1.7955	2.0109	2.1546	2.2982	2.5885	2.8728	3.4473	6½
6¾	.3098	.4647	.6196	.7745	.9294	1.084	1.239	1.394	1.549	1.858	2.168	2.323	2.479	2.788	3.098	3.716	6¾
7	.3332	.4998	.6664	.833	.9996	1.1662	1.3328	1.4994	1.666	1.9992	2.3324	2.499	2.6656	2.9988	3.332	3.9984	7
7¼	.3584	.5376	.7168	.896	1.075	1.254	1.433	1.612	1.792	2.15	2.508	2.688	2.867	3.225	3.584	4.301	7¼
7½	.3852	.5778	.7704	.963	1.1556	1.3482	1.5408	1.7334	1.926	2.3112	2.6964	2.889	3.0816	3.4668	3.852	4.6224	7½
8	.4352	.6528	.8704	1.088	1.3056	1.5232	1.7408	1.9584	2.176	2.6112	3.0464	3.264	3.4816	3.9168	4.352	5.2224	8
9	.5508	.8262	1.1016	1.377	1.6524	1.9278	2.2032	2.4786	2.754	3.3048	3.8556	4.131	4.4064	5.0572	5.508	6.6096	9
10	.68	1.02	1.36	1.7	2.04	2.38	2.72	3.06	3.4	4.08	4.76	5.1	5.44	6.12	6.8	8.16	10
11	.8227	1.2341	1.6455	2.057	2.4864	2.870	3.2911	3.7258	4.1139	4.9367	5.7595	6.1709	6.5823	7.4051	8.2279	9.8735	11
12	.9792	1.4688	1.9584	2.448	2.9376	3.4272	3.9168	4.4064	4.896	5.8752	6.8544	7.344	7.833	8.8128	9.792	11.7504	12
13	1.149	1.723	2.297	2.872	3.445	4.022	4.596	5.170	5.745	6.894	8.042	8.616	9.193	10.34	11.49	13.78	13
14	1.332	1.998	2.665	3.331	3.997	4.664	5.33	5.996	6.663	7.994	9.328	9.993	10.66	11.99	13.32	15.98	14
15	1.529	2.294	3.059	3.824	4.589	5.354	6.119	6.884	7.649	9.178	10.70	11.47	12.23	13.76	15.30	18.35	15
16	1.739	2.61	3.48	4.35	5.22	6.09	6.96	7.83	8.703	10.44	12.18	13.05	13.92	15.66	17.4	20.88	16
18	2.199	3.298	4.398	5.498	6.596	7.697	8.796	9.895	10.99	13.19	15.39	16.49	17.59	19.79	21.98	26.38	18
20	2.715	4.072	5.43	6.787	8.145	9.502	10.86	12.22	13.58	16.29	19.01	20.36	21.72	24.43	27.15	32.58	20

Friction of Water in Pipes

Friction loss in pounds per square inch for each 100 feet of different size clean iron pipe discharging given quantity of water per minute.

Gallons per Minute	Inside Diameter of Pipe																		
	¼ in.	1 in.	1¼ in.	1½ in.	2 in.	2½ in.	3 in.	4 in.	5 in.	6 in.	8 in.	10 in.	12 in.	14 in.	16 in.	18 in.	20 in.	24 in.	30 in.
5	3.3	.84	.31	.12															
10	13.0	3.16	1.05	.47	.12														
15	28.7	6.98	2.38	.97															
20	50.4	12.3	4.07	1.66	.42														
25	78.0	20.0	6.40	2.62		21	10												
30		27.5	9.15	3.75	.91														
35		37.0	12.4	5.05															
40		48.0	16.1	6.52	1.60														
45			20.2	8.15															
50			24.9	10.0	2.44	.81	.35	.09	0.05										
75			56.1	22.4	5.32	1.80	.74		0.06										
100				39.0	9.46	3.20	1.32	33	0.10	05									
125					14.9	4.89	1.90		0.16										
150					21.2	7.00	2.85	.69	0.23	10									
175					28.1	9.46	3.85		0.32										
200					37.5	12.47	5.02	1.22	0.42	17									
250						19.66	7.76	1.89	0.65	26	.07	.03	.01						
300						28.06	11.2	2.66	0.94	37	.09	04							
350							15.2	3.65	1.28	.50	.12	.05	.02						
400							19.5	4.73	1.68	.65	16	.06							
450							25.0	6.01	2.10	.81	20	.07	.03						
500							30.8	7.43	2.70	96	.25	.09	.04	.017	.009				
750									5.40	2.21	.53	18	.08						
1000									9.60	3.88	.94	.32	13	.062	.030				
1250											1.46	.49	20						
1500											2.09	.70	.29	135	.071				
1750												95	38						
2000												1.23	49	.234	123				
2250													63						
2500													77	.362	188	.107			
3000													1.11	515	.267	.150	.091	.047	
3500														.697	.365	.204			
4000														.910	.472	.264	.158	.067	.022
4500															593	.333			
5000															730	.408	244	.102	.035
6000																585	348	146	.048
7000																	472	.196	.065
8000																	.612	255	.083
9000																		323	.105
10000																		398	131

Table of Theoretical Horse Power Required to Raise Water to Different Heights

Gallons per Minute	5 feet	10 feet	15 feet	20 feet	25 feet	30 feet	35 feet	40 feet	45 feet	50 feet	60 feet	75 feet	90 feet	100 feet	125 feet	150 feet	175 feet	200 feet	250 feet	300 feet	350 feet	400 feet	Gallons per Minute
5	.006	.012	.019	.025	.031	.37	.44	.5	.56	.62	.75	.09	1.1	1.2	1.6	1.9	2.2	.25	3.1	.37	.44	.50	5
10	.012	.025	.037	.050	.062	.075	.87	1.0	1.1	1.2	1.5	1.8	2.2	2.5	3.1	.37	.44	.50	.62	.75	.87	1.00	10
15	.019	.037	.056	.075	.094	1.12	1.3	1.5	1.7	1.9	2.2	2.8	3.4	3.7	.47	.56	.66	.75	.94	1.12	1.31	1.50	15
20	.025	.050	.075	1.0	1.25	1.5	1.75	2.0	2.2	2.5	3.0	3.7	4.5	5.0	.62	.75	.87	1.00	1.25	1.50	1.75	2.00	20
25	.031	.062	.094	1.25	1.56	1.87	2.19	2.5	2.8	3.1	3.7	4.7	5.6	6.2	.78	.94	1.09	1.25	1.56	1.87	2.19	2.50	25
30	.037	.075	1.12	1.5	1.87	2.25	2.62	3.0	3.4	3.7	4.5	5.6	6.7	7.5	.94	1.12	1.31	1.50	1.87	2.25	2.62	3.00	30
35	.043	.087	1.31	1.7	2.19	2.62	3.06	3.5	3.9	4.4	5.2	6.6	7.9	8.7	1.08	1.31	1.53	1.75	2.19	2.62	3.06	3.50	35
40	.050	1.00	1.50	2.00	2.50	3.00	3.50	4.0	4.5	5.0	6.0	7.5	9.0	10.0	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	40
45	.056	1.12	1.68	2.25	2.81	3.37	3.94	4.5	5.1	5.6	6.7	8.4	10.1	11.2	1.41	1.69	1.97	2.25	2.81	3.37	3.94	4.50	45
50	.062	1.25	1.87	2.5	3.12	3.75	4.37	5.0	5.6	6.2	7.5	9.4	11.2	12.5	1.56	1.87	2.19	2.50	3.12	3.75	4.37	5.00	50
60	.075	1.50	2.25	3.00	3.75	4.50	5.25	6.0	6.7	7.5	9.0	1.12	1.35	1.50	1.87	2.25	2.62	3.00	3.75	4.50	5.25	6.00	60
75	.093	1.87	2.81	3.75	4.69	5.62	6.56	7.5	8.4	9.4	1.12	1.40	1.69	1.87	2.34	2.81	3.28	3.75	4.69	5.62	6.56	7.50	75
90	1.12	2.25	3.37	4.50	5.62	6.75	7.87	9.0	2.01	1.12	1.35	1.68	2.02	2.25	2.81	3.37	3.94	4.50	5.62	6.75	7.87	9.00	90
100	1.25	2.50	3.75	5.0	6.25	7.50	8.75	10.0	11.2	12.5	1.50	1.87	2.25	2.50	3.12	3.75	4.37	5.00	6.25	7.50	8.75	10.00	100
125	1.56	3.12	4.69	6.25	7.81	9.37	10.94	12.5	1.41	1.56	1.87	2.34	2.81	3.12	3.91	4.69	5.47	6.25	7.81	9.37	10.94	12.50	125
150	1.87	3.75	5.62	7.50	9.37	11.25	13.12	15.0	1.69	1.87	2.25	2.81	3.37	3.75	4.69	5.62	6.56	7.50	9.37	11.25	13.12	15.00	150
175	2.19	4.37	6.56	8.75	10.93	13.12	15.31	17.5	1.97	2.19	2.62	3.28	3.94	4.37	5.47	6.56	7.66	8.75	10.94	13.12	15.31	17.50	175
200	2.50	5.00	7.50	10.00	12.50	15.00	17.50	20.0	2.25	2.50	3.00	3.75	4.50	5.00	6.25	7.50	8.75	10.00	12.50	15.00	17.50	20.00	200
250	3.12	6.25	9.37	12.50	15.62	18.75	21.87	25.0	2.81	3.12	3.75	4.69	5.62	6.25	7.81	9.37	10.94	12.50	15.62	18.75	21.87	25.00	250
300	3.75	7.50	11.25	15.00	18.75	22.50	26.25	30.0	3.37	3.75	4.50	5.62	6.75	7.50	9.37	11.25	13.12	15.00	18.75	22.50	26.25	30.00	300
350	4.37	8.75	13.12	17.50	21.87	26.25	30.62	35.0	3.94	4.37	5.25	6.56	7.87	8.75	10.94	13.12	15.31	17.50	21.87	26.25	30.62	35.00	350
400	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.0	4.50	5.00	6.00	7.50	9.00	10.00	12.50	15.00	17.50	20.00	25.00	30.00	35.00	40.00	400
450	.844	1.688	2.531	3.375	4.219	5.062	5.906	6.75	7.594	8.438	10.13	12.66	15.19	16.88	21.09	25.31	29.53	33.75	42.19	50.62	59.06	67.50	450
500	.938	1.875	2.812	3.750	4.688	5.625	6.562	7.50	8.438	9.375	11.25	14.06	16.88	18.75	23.44	28.12	32.81	37.50	46.88	56.25	65.62	75.00	500

le for Converting Feet Head of Water into Pressure per Square Inch

et ead	Pounds per Square Inch	Feet Head	Pounds per Square Inch	Feet Head	Pounds per Square Inch
1	.43	55	23.82	190	82.29
2	.87	60	25 99	200	86.62
3	1.30	65	28.15	225	97.45
4	1.73	70	30.32	250	108.27
5	2.17	75	32.48	275	119.10
6	2 60	80	34.65	300	129.93
7	3.03	85	36.81	325	140.75
8	3.40	90	38.98	350	151.58
9	3.90	95	41.14	375	162.41
0	4.33	100	43.31	400	173.24
5	6.50	110	47.64	500	216.55
0	8 66	120	51.97	600	259.85
5	10.83	130	56.30	700	303.16
0	12.99	140	60.63	800	346.47
5	15.16	150	64.96	900	389.78
0	17.32	160	69.29	1000	433.09
5	19.49	170	73.63	. .	. . .
0	21 65	180	77.96	. .	. . .

le for Converting Pressure per Square Inch into Feet Head of Water

ds per Square Inch	Feet Head	Pounds per Square Inch	Feet Head	Pounds per Square Inch	Feet Head
1	2 31	55	126.99	180	415.61
2	4.62	60	138.54	190	438.90
3	6.93	65	150.08	200	461.78
4	9.24	70	161.63	225	519.51
5	11.54	75	173.17	250	577.24
6	13.85	80	184.72	275	643.03
7	16.16	85	196 26	300	692.69
8	18.47	90	207.81	325	750.41
9	20.78	95	219 35	350	808.13
10	23.09	100	230.90	375	865.89
15	34.63	110	253.98	400	922.58
20	46 18	120	277.07	500	1154.48
25	57.72	125	288.62	. .	. . .
30	69 27	130	300.16	. .	. . .
35	80.81	140	323.25	. .	. . .
40	92.36	150	346.34	. .	. . .
45	103.90	160	369.43	. .	. . .
50	115.45	170	392.52	. .	. . .

Areas of Circles

Diam	Area	Diam	Area	Diam	Area	Diam	Area	Diam	Area	Diam	Area	Diam.	Area
⅛	.012	4 inches	12.56	13 inches	132.73	22 inches	380.13	31 inches	754.7	40 inches	1256.6	49 inches	1885.7
¼	.049	⅓	15.90	½	143.1	¾	397.60	½	779.1	½	1288.1	½	1924.4
⅜	.110	5 inches	19.63	14 inches	153.94	23 inches	415.47	32 inches	804.2	41 inches	1320.2	50 inches	1963.5
½	.196	⅓	23.75	½	165.13	¼	433.74	½	829.5	½	1353.6	½	2002.9
⅝	.441	6 inches	28.27	15 inches	176.71	24 inches	452.39	33 inches	855.3	42 inches	1385.4	51 inches	2042.8
1 inch	.785	⅓	33.18	½	188.69	½	471.43	½	881.4	½	1418.6	½	2083.0
⅛	.994	7 inches	38.48	16 inches	201.06	25 inches	490.8	34 inches	907.9	43 inches	1452.2	52 inches	2123.7
¼	1.227	⅓	44.17	½	213.82	½	510.7	½	934.8	½	1486.1	½	2164.7
⅜	1.767	8 inches	50.26	17 inches	226.98	26 inches	530.9	35 inches	962.1	44 inches	1520.5	53 inches	2206.2
½	2.405	⅓	56.74	½	240.52	½	551.5	½	989.8	½	1555.2	½	2248.0
2 inches	3.141	9 inches	63.61	18 inches	254.46	27 inches	572.5	36 inches	1017.8	45 inches	1590.4	54 inches	2290.2
⅛	3.976	⅓	70.88	½	268.80	⅓	593.9	½	1046.3	½	1625.9	½	2332.8
¼	4.908	10 inches	78.54	19 inches	283.53	28 inches	615.7	37 inches	1075.2	46 inches	1661.9	55 inches	2375.8
⅜	5.930	⅓	86.59	½	298.74	⅓	637.9	½	1104.4	½	1698.2	½	2419.2
3 inches	7.06	11 inches	95.03	20 inches	314.16	29 inches	660.5	38 inches	1134.1	47 inches	1734.9	56 inches	2463.0
⅛	8.29	⅓	103.87	½	330.06	⅓	683.4	½	1164.1	½	1772.0	½	2507.1
¼	9.62	12 inches	113.10	21 inches	346.36	30 inches	706.8	39 inches	1194.6	48 inches	1808.5	57 inches	2551.7
⅜	11.04	⅓	122.71	½	363.05	½	730.6	½	1225.4	½	1847.4	½	2596.7

Barometric Pressures at Different Altitudes, with Equivalent Head of Water and the Vertical Suction Lift of Pumps

Altitude	Barometric Pressure	Equivalent Head of Water	Practical Suction Lift of Pumps
Sea Level	14.70 pounds per square inch	33.95 feet	25 feet
½ mile (1320 feet) above sea level	14.09 " " "	32.38 "	24 "
½ " (2640 ") " "	13.53 " " "	30.70 "	23 "
" (3960 ") "	12.96 " " "	29.24 "	22 "
" (5280 ")	12.02 " " "	27.76 "	20 "
" (6600 ") "	11.48 " " "	26.38 "	19 "

Width of Belt in Inches	Horse Power per 100 Feet Velocity of Belt	
	Single Belt	Double Belt
1	.09	.18
2	.18	.36
3	.27	.55
4	.36	.73
5	.45	.91
6	.55	1.09
7	.64	1.27
8	.73	1.46
9	.82	1.64
10	.91	1.82
11	1.00	2.00

Width of Belt in Inches	Horse Power per 100 Feet Velocity of Belt	
	Single Belt	Double Belt
12	1.09	2.18
14	1.27	2.55
16	1.45	2.91
18	1.64	3.27
20	1.82	3.64
22	2.00	4.00
24	2.18	4.36
28	2.55	5.09
32	2.91	5.82
36	3.27	6.55
40	3.64	7.27

In the calculations for horse powers in the above table, the belt is assumed to run about horizontally, the semi-circumference of smaller pulley has been considered as the ordinary arc contact of belt. Any reduction of this contact will make approximate proportional reduction of horse power.

Horse Power Shafting Will Transmit

Diameter of Shaft in Inches	Revolutions per Minute									
	100	125	150	175	200	225	250	300	350	400
1 15/16	1.2 h. p.	1.4 h. p.	1.7 h. p.	2.1 h. p.	2.4 h. p.	2.6 h. p.	3.1 h. p.	3.6 h. p.	4.3 h. p.	5.0 h. p.
2 1/16	2.4 "	3.1 "	3.7 "	4.3 "	4.9 "	5.5 "	6.1 "	7.3 "	8.5 "	9.7 "
2 1/8	4.3 "	5.3 "	6.4 "	7.4 "	8.5 "	9.5 "	10.5 "	12.7 "	14.8 "	16.9 "
2 3/16	6.7 "	8.4 "	10.1 "	11.7 "	13.4 "	15.1 "	16.7 "	20.1 "	23.4 "	26.8 "
2 1/4	10.0 "	12.5 "	15.0 "	17.5 "	20.0 "	22.5 "	25.0 "	30.0 "	35.0 "	40.0 "
2 5/16	14.3 "	17.8 "	21.4 "	24.9 "	28.5 "	32.1 "	35.6 "	42.7 "	49.8 "	57.0 "
2 3/8	19.5 "	24.4 "	29.3 "	34.1 "	39.0 "	44.1 "	48.7 "	58.5 "	68.2 "	78.0 "
2 7/16	26.0 "	32.5 "	39.0 "	45.5 "	52.0 "	58.5 "	65.0 "	78.0 "	87.0 "	104.0 "
2 1/2	33.8 "	42.2 "	50.6 "	59.1 "	67.5 "	75.9 "	84.4 "	101.3 "	118.2 "	135.0 "
2 9/16	43.0 "	53.6 "	64.4 "	75.1 "	85.8 "	96.6 "	107.3 "	128.7 "	150.3 "	171.6 "
2 5/8	53.6 "	67.0 "	79.4 "	93.8 "	107.2 "	120.2 "	134.0 "	158.8 "	187.6 "	214.4 "
2 11/16	65.9 "	82.4 "	97.9 "	115.4 "	121.8 "	148.3 "	164.8 "	195.7 "	230.7 "	243.6 "
2 3/4	80.0 "	100.0 "	120.0 "	140.0 "	160.0 "	180.0 "	200.0 "	240.0 "	280.0 "	320.0 "
2 13/16	113.9 "	142.4 "	170.8 "	199.3 "	227.8 "	256.2 "	284.7 "	341.7 "	398.6 "	455.6 "
2 15/16	156.3 "	195.3 "	234.4 "	273.4 "	312.5 "	351.5 "	390.6 "	468.7 "	546.8 "	625.0 "

Gallons of 231 Cubic Inches per Foot of Piston Travel.

Diam.	Gallons.	Diam	Gallons	Diam	Gallons	Diam	Gallons
		7	1.9902	17	11.7412	27	29.7831
1/8	0.0006	1/4	2.0445	1/8	12.1405	1/8	30.2265
1/4	0.0025	1/2	2.0950	1/4	12.4997	1/4	30.6598
3/8	0.0057	3/4	2.1505	3/8	12.8645	3/4	31.4185
1/2	0.0102	8	2.2112	18	13.2292	28	31.7851
5/8	0.0159	1/8	2.7769	1/8	13.5869	1/8	32.1609
3/4	0.0229	1/4	2.9478	1/2	13.9638	1/4	32.5397
7/8	0.0312	3/8	3.1237	3/4	14.3437	3/4	33.3125
1	0.0408	9	3.3048	19	14.7288	29	34.1137
1/8	0.0516	1/8	3.4909	1/8	15.1189	1/8	34.9189
1/4	0.0637	1/2	3.6822	1/4	15.5141	1/2	35.7281
3/8	0.0771	3/4	3.8785	3/8	15.9145	3/4	36.5414
1/2	0.0918	10	4.0800	20	16.3199	30	36.3589
5/8	0.1077	1/4	4.2865	1/4	16.7305	1/4	37.3344
3/4	0.1249	1/2	4.4982	1/2	17.1461	1/2	37.3138
7/8	0.1434	3/4	4.7149	3/4	17.5669	3/4	38.1998
2	0.1632	11	4.9368	21	17.9927	31	39.0897
1/4	0.1842	1/4	5.1637	1/4	18.4237	1/4	39.9836
3/8	0.2065	1/2	5.3958		18.8597	1/2	40.8817
1	0.2301	3/4	5.6330	3/4	19.3008	3/4	41.7838
1/8	0.2549	12	5.8752	22	19.7471	32	42.6900
1/4	0.2810	1/4	6.1225	1/4	20.1985	1/4	43.6001
3/8	0.3084	1/2	6.3750	1/2	20.6549	1/2	44.5143
1/2	0.3372	3/4	6.6325	3/4	21.1165	3/4	45.4326
5/8	0.3672	13	6.8952	23	21.5831	33	46.3551
3/4	0.3986	1/4	7.1629	1/4	22.0549	1/4	47.2815
7/8	0.4313	1/2	7.4358	1/2	22.5317	1/2	48.2120
3	0.4653	3/4	7.7137	3/4	23.0137	3/4	49.1467
1/8	0.5006	14	7.9968	24	23.5007	34	50.0854
1/4	0.5373	1/4	8.2850	1/4	23.9929	1/4	51.0282
3/8	0.5753	1/2	8.5782	1/2	24.4901	1/2	51.9750
1/2	0.6147	3/4	8.8765	3/4	24.9925	3/4	52.9260
5/8	0.6554	15	9.1800	25	25.4999	35	53.8811
3/4	0.6975	1/4	9.4885	1/4	26.0125	1/4	54.8402
7/8	0.7409	1/2	9.8022	1/2	26.5301	1/2	55.8034
4	0.7857	3/4	10.1209	3/4	27.0524	3/4	56.7708
1/8	0.8317	16	10.4448	26	27.5807	36	57.7422
1/4	0.8792	1/4	10.7737	1/4	28.1137	1/4	58.7176
3/8	0.9279	1/2	11.1078	1/2	28.6517	1/2	59.6971
1/2	0.9780	3/4	11.4469	3/4	29.1949	3/4	60.6807
5/8	1.0294						
3/4	1.0821						
7/8	1.1362						
5	1.1916						
1/8	1.2483						
1/4	1.3064						
3/8	1.3658						
6	1.4266						
1/4	1.4888						
1/2	1.5523						
3/4	1.6172						

Relation Between Temperature of Feed Water and Evaporative Capacity of Boiler.

Temperature of Feed Water. Degrees Fahr.	Steam Pressure. Pounds.	Feed Water per Horse-Power per Hour. Pounds.	Gallons per Minute per 100 Horse-Power.
100	70	*30.00	6.02 + 10 per cent. = 6.62
70	100	29.04	5.79 + 10 " " = 6.36
100	100	29.82	5.98 + 10 " " = 6.57
150	100	31.22	6.34 + 10 " " = 6.97
180	100	32.14	6.61 + 10 " " = 7.27
200	100	32 77	6.65 + 10 " " = 7.31
212	100	33.17	6.94 + 10 " " = 7.63

*This is the standard adopted by the American Society of Mechanical Engineers, and is the generally accepted commercial standard by boiler makers and users.

The evaporative capacity of a boiler depends, among other things, upon the steam pressure and temperature of the feed water. The pressure makes so little difference that it has been estimated for 100 pounds as practically correct for all pressures. The difference between making steam at atmospheric pressure and 100 pounds pressure is only 3½ per cent. Changing the temperature of the feed water from 100 degrees to 212 degrees will vary the evaporative capacity of a boiler over 11 per cent.

Quantity of Feed Water Required to Supply Boiler.

Horse-Power of Boiler.	Quantity of Feed Water Required.		Temperature of Feed Water. Degrees Fahr.
	Gallons per Minute.	Pounds per Hour.	
50	3.60 to 4.20	1599 to 2020	100 to 212
100	6.57 to 7.63	3285 to 3815	100 to 212
200	13.14 to 15.26	6590 to 7630	100 to 212
250	16.43 to 19.07	8215 to 9535	100 to 212
300	19.71 to 22.89	9855 to 11445	100 to 212
400	26.28 to 30.52	13140 to 15260	100 to 212
500	32.85 to 38.15	16425 to 19075	100 to 212
600	39.42 to 45.78	19710 to 22890	100 to 212
800	52.26 to 61.04	26280 to 30520	100 to 212
1000	65.70 to 76.30	32350 to 38150	100 to 212
1200	78.84 to 91.56	39420 to 45780	100 to 212
1500	98.55 to 114.45	49275 to 57225	100 to 212
1800	118.26 to 137.34	59130 to 68670	100 to 212
2200	144.50 to 167.80	71290 to 83930	100 to 212
3000	197.10 to 228.90	98500 to 114500	100 to 212
3500	229.95 to 267.05	114975 to 133525	100 to 212
4500	295.65 to 343.35	147825 to 171675	100 to 212
6000	394.20 to 457.80	197100 to 228900	100 to 212
7000	459.90 to 534.10	229950 to 267050	100 to 212

French or Metric Measures.

The metric unit of length is the meter = 39.37 inches.
The metric unit of weight is the gram = 15.432 grains.
The following prefixes are used for sub-divisions and multiples: Milli = $\frac{1}{1000}$, Centi. = $\frac{1}{100}$, Deci = $\frac{1}{10}$, Deca. = 10, Hecto. = 100, Kilo. = 1,000, Myria. = 10,000.

French and British (and American) Equivalent Measures.

Measures of Length.

French.	British and United States.
Meter	= 39.37 inches, or 3.28083 feet, 1 09361 yds.
3048 Meter	= 1 foot.
Centimeter . .	= .3937 inch
.54 Centimeters	= 1 inch.
Millimeter .	= 03937 inch, or $\frac{1}{25}$ inch nearly
5.4 Millimeters	= 1 inch.
Kilometer .	= 1093.61 yards, or 0.62137 mile.

Measures of Capacity.

Liter (=1 cubic decimeter) = .	61.023 cubic inches. .03531 cubic foot. .2642 gallon (United States). 2.202 pounds of water at 62 degrees Fahrenheit.
8.317 Liters	= 1 cubic foot.
4.543 Liters .	= 1 gallon (British).
3.785 Liters . .	= 1 gallon (United States).
British gallon	= 1.2 (United States) gallon.

Measures of Weight.

Gram	= 15.432 grains.
.0648 Gram	= 1 grain.
8.35 Grams	= 1 ounce avoirdupois.
Kilogram	= 2.2046 pounds.
.4536 Kilogram	= 1 pound.
Tonne or Metric Ton	= .9842 ton of 2240 pounds.
	= 19.68 cwts.
1000 Kilograms	= 2204.6 pounds.
Tons	= 1 ton of 2240 pounds.

Business Correspondence.

hen writing for prices or information regarding machinery, delays may be avoided by answering all the following questions which may be applicable to your case.

st. For what service is pump required?
d. What quantity of water is to be lifted per minute?
How many pounds, gallons, cubic feet, or litres?
What is the average quantity?
What is the maximum quantity?
d. What will be the water pressure in pounds per square inch at the pump; or, what is the total height that water is to be raised?
If the pressure is liable to change, due to change of lift, etc., what is the normal pressure at which pump must work?
What is the maximum pressure?
What is the pressure at which pump must give greatest economy?
h. What is the suction lift; in other words, how far above the water to be pumped will be the top of foundation for pump?
If pump is to be situated some distance from the sump, what will be the distance of pump from same; or, in other words, what will be the length of suction pipe?
If suction pipe is already installed, what is length and diameter?
h. What will be the length of discharge pipe?
If piping is already in, what is the diameter, length, thickness, and kind of piping?
h. What is temperature of water?
Is the water clear or gritty, salt, fresh, or acid?
About what is the proportion of sand or other sediment?
h. Is there a good bed for foundation at proposed site of pumping engine?
What is the character of same?
h. Is pumping engine to be situated in mine; or, on the surface?
h. Is pump to be driven by direct connection, belt, gearing, or rope transmission?
h. If by electric motor, what will be the voltage at motor?
What is the effective horse-power and type of motor?
What is the number of alternations per minute?
What is working speed of motor?
h. What other information can you give us regarding the character of required plant and locality?
h. In case machinery is to go down in mine or in tunnel, what is the size of the mine shaft or tunnel, in the clear? (We should know this in order to design the different parts so that they can easily pass through shaft or tunnel.)
-h. Is machinery to be made sectional for mule-back transportation?
th. If made sectional, what is limit weight?
th. How many pieces of maximum weight allowable may be shipped?

REMARKS.

In case certain of the above questions cannot be answered on account of not derstanding conditions, or not having available data, please send all informa-n at hand bearing on the subject, and we will endeavor to give you the best lution of the problem.

When shafting of any description enters into the proposition, care should be ken to give diameter and number of revolutions per minute.

Often a rough pencil sketch with explanations serves to convey clearly what is quired.

Communications plainly stating facts as above called for will often save much ne and tend to *greater satisfaction.*

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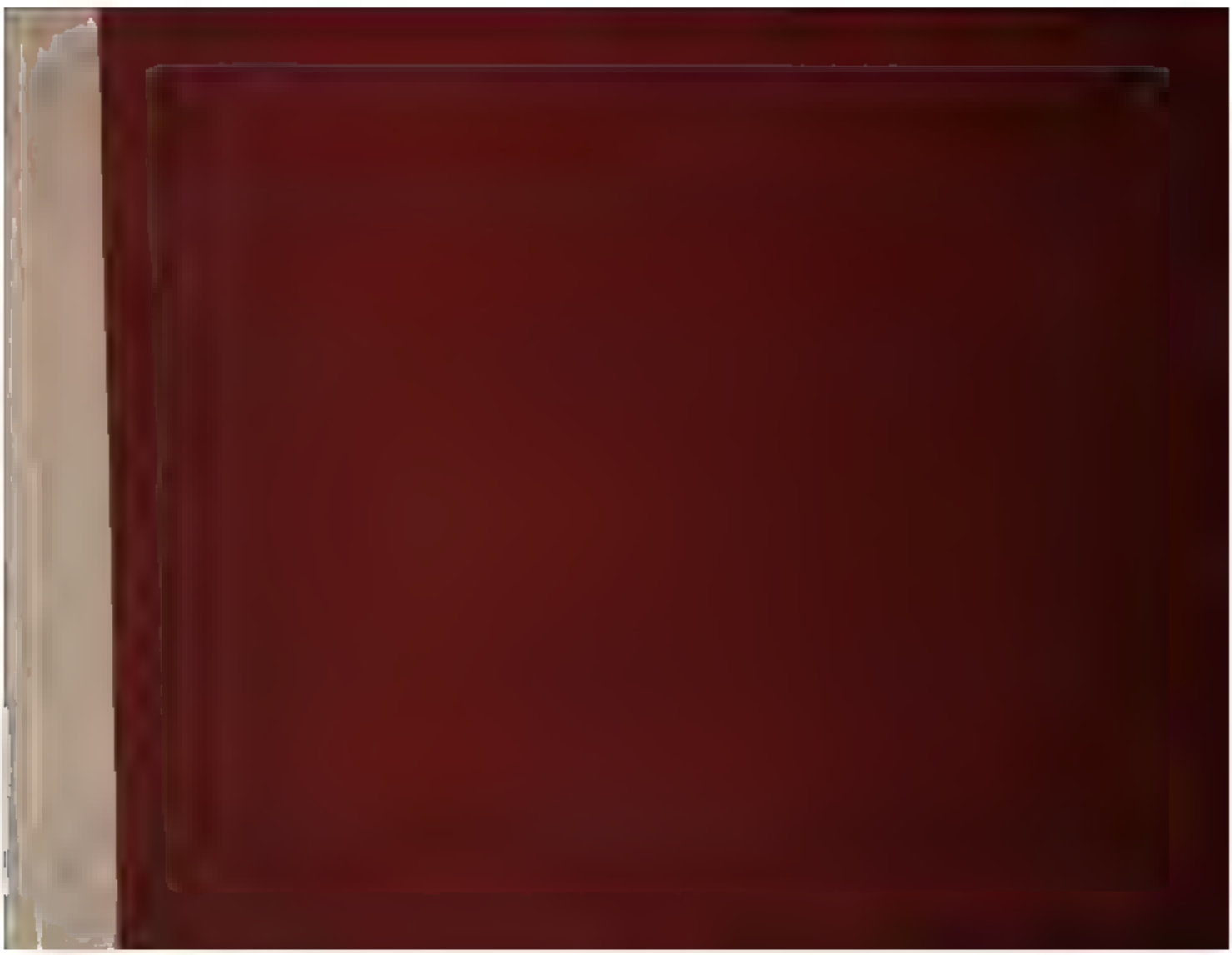

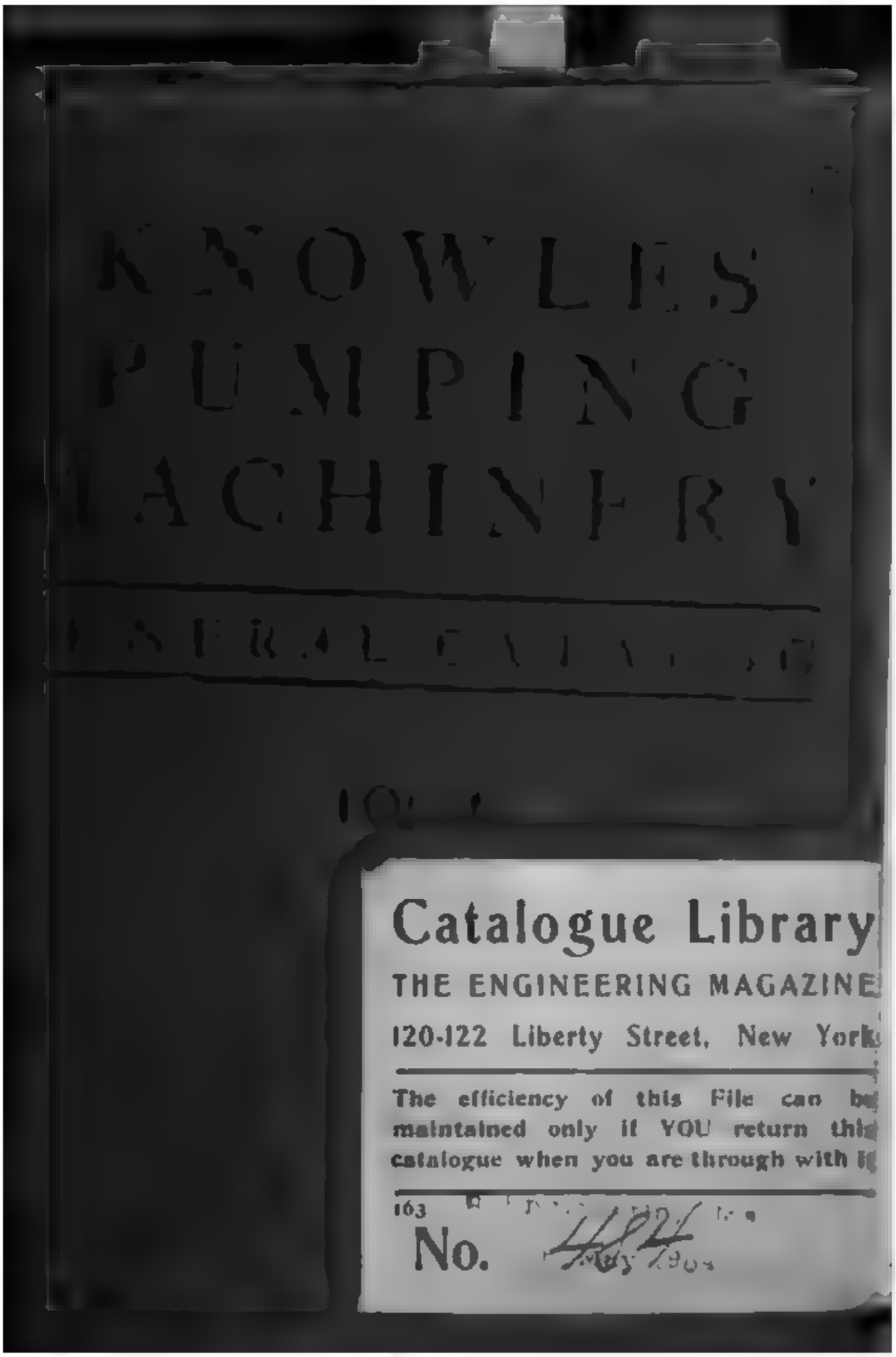
KNOWLES
PUMPING
MACHINERY
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No.

NOWLES STEAM PUMP WORKS,
114 TO 118 LIBERTY STREET. NEW YORK.
WORKS: EAST CAMBRIDGE, MASS.
CHICAGO:
EW YORK LIFE BUILDING.
LONDON:
179 QUEEN VICTORIA ST.
BOSTON: 54 OLIVER ST.

To Our Patrons.

THIS revised Catalogue we have endeavored to give full particulars and illustrations of as many designs as possible of the Knowles Improved Pumping Machinery, but the extent of our ness is such that we cannot do the subject justice within the its of a catalogue as convenient as this size is.

We are constantly bringing out new specialties in our line, and apting the Knowles Patent Direct-acting Pumping System to new chanical purposes which the growing industries of the country ntinually demand.

We therefore solicit correspondence from our patrons and ers who do not find within these pages designs of pumping chinery adapted to their special requirements. We will gladly nish them with plans and estimates on receipt of full particulars.

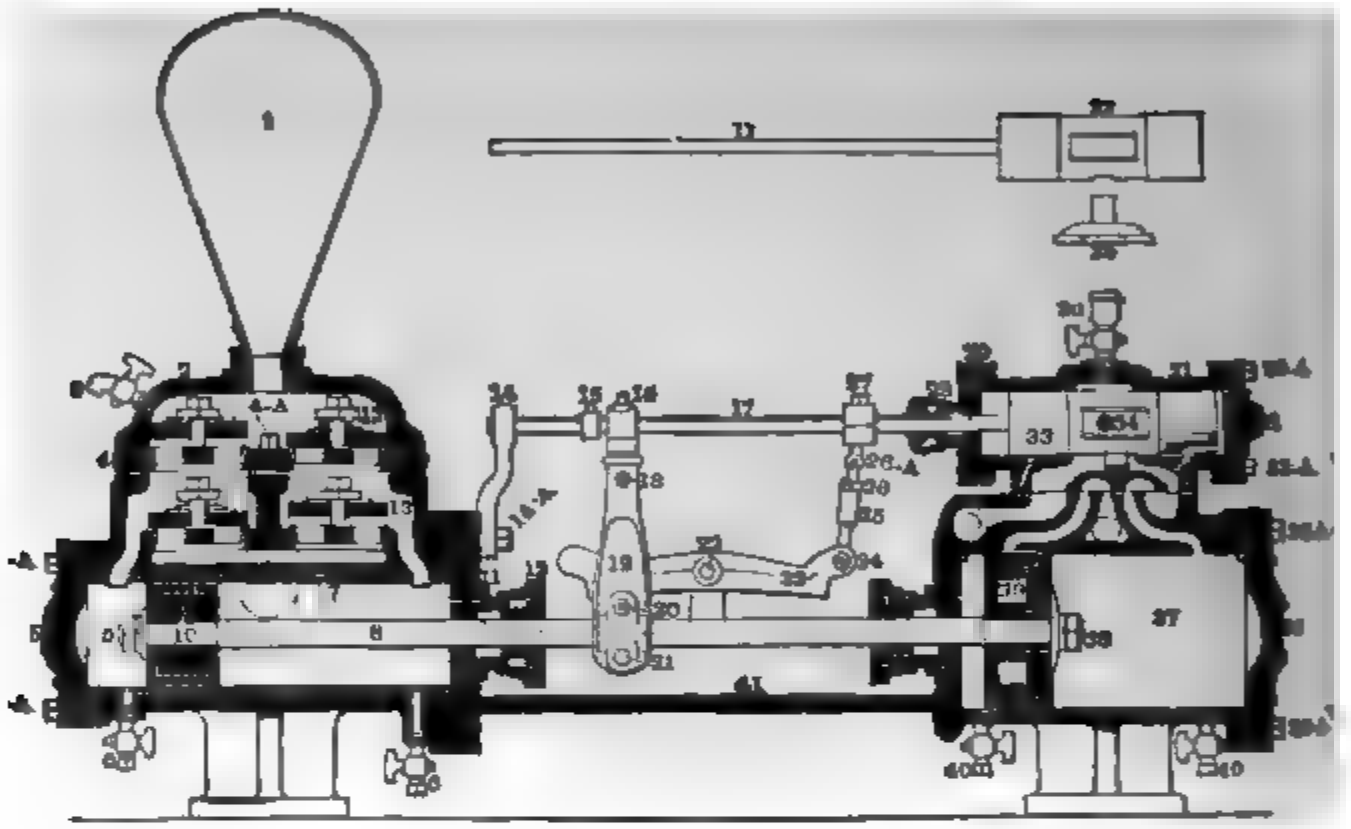
Our Guarantee.

Each and every pump built and sold by us is furnished fully aranteed; in case of the failure of any of our machines to properly rm the service for which they are warranted, we hold our- under obligation to make the same fully satisfactory, or to l the price paid for same.

Knowles Steam Pump Works.

1898.

[redacted]



NOTICE.

THAT the distinctive features of the Knowles valve motion and its great simplicity may be clearly understood, and the superior merits of the pump more fully appreciated, we call especial attention to the following points, viz.:

1. Should a pump run longer stroke one way than the other, simply lengthen or shorten the rocker connection (Part 25) so that rocker bar (Part 23) will touch rocker roller (20) equally distant from center (22).

2. Should a pump hesitate in making its return stroke, it is because rocker roller (20) is too low and does not come in contact with the rocker bar (23) soon enough. To raise it, take out rocker roller stud (20-A), give the set screw in this stud a sufficient downward turn, and the stud with its roller may at once be raised to proper height.

3. Should valve rod (17) ever have a tendency to tremble, slightly tighten up the valve rod stuffing box nut (28). When the valve motion is properly adjusted, tappet tip (16) should not quite touch collar (15) and clamp (27). Rocker roller (20), coming in contact with rocker bar (23) will reverse the stroke.

4. The water piston is adjustable by means of segments that can be seen by taking off the follower, and the packing quickly set out to always insure perfect suction and at the same time not be so tight as to bind.

From the above it will be seen that every wearing part is made adjustable, easily gotten at, and to remedy any trouble it is rarely necessary to take a pump apart, which are points that strongly commend our pump to every user.

KNOWLES STEAM PUMP WORKS.

[redacted]

KNOWLES PATENT
DIRECT-ACTING STEAM PUMP.

MANY a good steam pump is misused and condemned simply from want of a clear understanding of the principle on which it is constructed. Trouble caused by derangement in the steam end of a pump is often thought to exist in the water cylinder, or vice versa. It is not uncommon to find pumps badly set up or improperly selected for their work; pipes are often used that are too small in size or defective in their arrangement. Trouble arising from these and other mistakes are too often wrongly attributed to the steam pump. It is, therefore, very desirable that the attendant should be familiar with the machine, so that he can at once locate any difficulty and remedy it with intelligence and promptness.

The KNOWLES DIRECT-ACTING STEAM PUMP is anything but an intricate or complicated machine. On the contrary it is very simple in its mechanism and readily understood; it requires but little trouble in its care or management, and very small expense is necessary to keep it in good repair.

EXPLANATION OF STEAM VALVES, ETC.

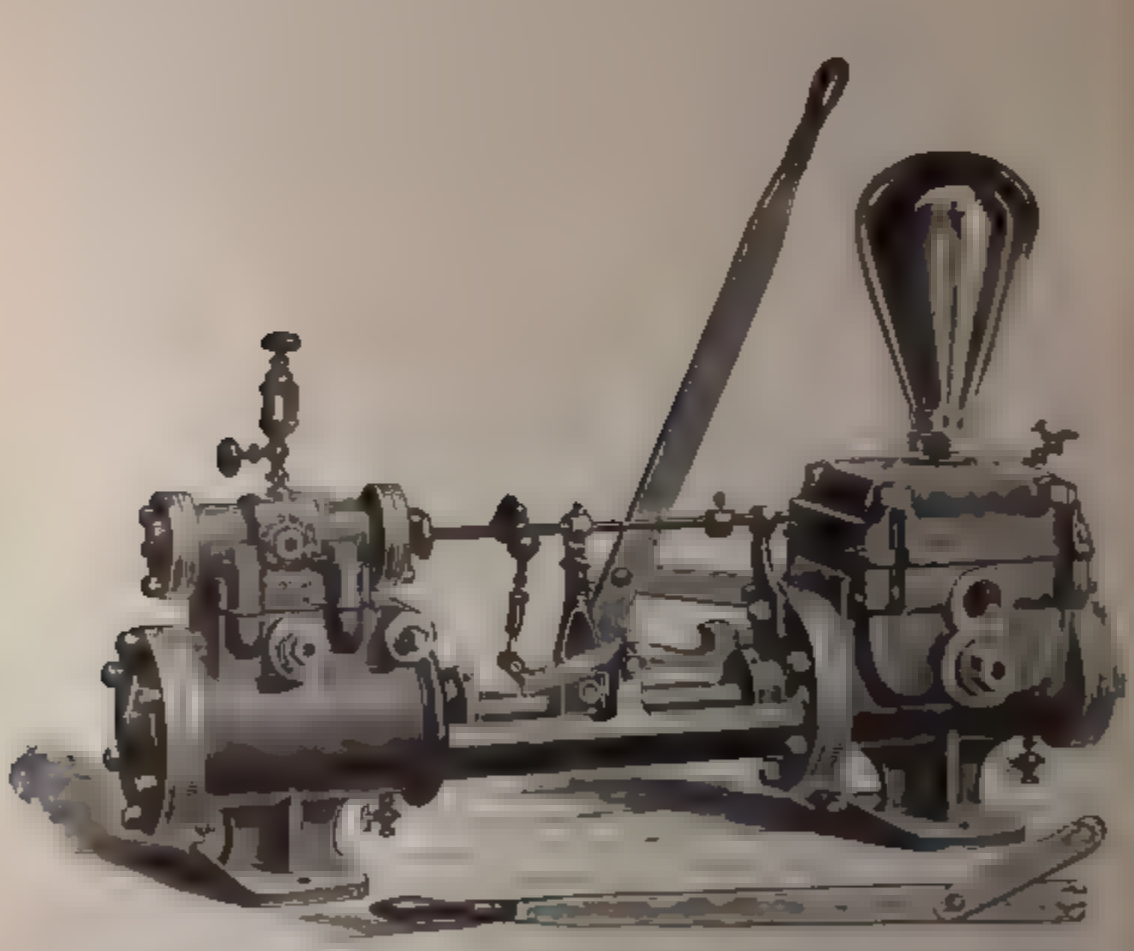
The prime advantage of the KNOWLES DIRECT-ACTING STEAM PUMP is its absolute freedom from what is termed a "*dead center.*" This feature is secured by a very simple and ingenious mechanical arrangement, *i. e.*, by the use of an auxiliary piston which works in the steam chest and drives the main valve. This auxiliary or "chest piston," as it is called, is driven backward and forward by the pressure of steam, carrying with it the main valve, which valve, in turn, gives steam to the main steam piston that operates the pump. This main valve is a plain slide valve of the B form, working on a flat seat.

The chest piston is slightly rotated by the valve motion; this rotative movement places the small steam ports (which are located in the under side of the said chest piston) in proper contact with corresponding ports cut in the steam chest. The steam entering through the the port at one end and filling the space between the chest piston and the head, drives the said piston to the end of its stroke and, as before mentioned, carries the main slide valve with it. (See illustration on opposite page.) When the chest piston has traveled a certain distance, a port on the opposite end is uncovered and steam there enters, stopping its further travel by giving it the necessary cushion. In other words, when the rotative motion is given to the auxiliary or valve driving piston by the mechanism outside, it opens the port to steam admission on one end, and at the same time opens the port on the other end to the exhaust. Thus instant and *positive* motion is secured with but few working parts. There is no point in the stroke at which either the chest piston or the main piston is not open to direct steam pressure. Hence the immunity from any dead point whatsoever. A description of the

OPERATION OF THE PUMP

is as follows: The piston-rod, with its tappet arm, moves backward and forward from the impulse given by the steam piston. At the lower part of this tappet arm is attached a stud or bolt on which there is a friction roller.* This roller, coming in contact with the "rocker bar" at the end of each stroke, operates the latter. The motion given the "rocker bar" is transmitted to the valve rod by means of the connection between, causing the valve rod to partially rotate. This action, as mentioned above, operates the chest piston, which carries with it the main slide valve. The said valve giving steam to the main piston, the operation of the pump is complete and continuous. The upper end of the tappet arm does not come in contact with the tappets on the valve rod, except the steam pressure from any cause should fail to move the chest piston, in which case the tappet arm moves it mechanically. This makes the pump absolutely positive.

* *This friction roller, with its bolt and nut, can be lowered or raised, when it is desired, to adjust the pump for a longer or shorter stroke.*



(Above cut shows No. 4½ size.)

KNOWLES PATENT BOILER-FEED OR PRESSURE PUMP

[redacted]

KNOWLES PATENT

ler Feed or Pressure Pumps.

Arranged for Hot or Cold Water or other Liquids.

---

rices have been introduced in the market for feeding boilers, but nothing has yet proved so economical as a good steam pump. The Knowles Pump has withstood the test of many e, and stands to-day preeminent for its record of efficiency and durability. In its present m it is the most desirable boiler feeder to be found. Its improved valve motion and steam : the smoothest work under the most exacting conditions. The pump can be regulated to eed desired—an important feature in the feeding of boilers.

nufacture of the Knowles Steam Pumps the best composition metal (Government standard) ie piston rods, stuffing boxes, valve seats, and water cylinder linings. The water pistons is of composition, and are packed with a special form of adjustable packing, adapted for cold liquids. All parts are made to gauge, and are therefore interchangeable.

mps have large direct water passages and full valve area, which admit of a speed that makes ficient *fire* pumps.

SIZES AND CAPACITIES.

Water Cylinder.	Stroke.	Gallons per Stroke.	Capacity per Minute at Maximum Speed		Steam Pipe.	Exhaust Pipe	Suction Pipe.	Delivery Pipe.	Floor Space Required.	Telegraphic Code Word.
Ins	Ins.		Strokes.	Gals.	Ins.	Ins.	Ins.	Ins.	Ins.	
1¼	3	.023	150	3½	¼	⅜	½	¾	18 x 4	Forel
1¾	3	.032	150	4¾	¼	⅜	¾	½	18 x 5	Forelift
2	4	.05	150	7½	½	¾	1¼	1	31 x 6	Forename
2¼	4	.07	150	10½	½	¾	1¼	1	29 x 7	Forensal
2½	5	.11	150	16½	½	¾	1¼	1	32 x 7	Forepart
3	7	.25	125	31	¾		2	1½	44 x 10	Forerank
3¼	7	.34	125	42	¾		2	1½	44 x 10	Foreread
4	7	.39	125	49	1	1¼	2½	2	45 x 10	Forerun
4½	10	69	100	69	1	1¼	3	2½	56 x 16	Foresail
5	10	.85	100	85	1	1¼	3	2½	56 x 16	Foresay
5	12	1.02	100	102	1	1¼	4	4	64 x 16	Foresee
6	12	1.47	100	147	1¼	1½	4	4	68 x 19	Foreship
7	12	2.00	100	200	2	2½	5	5	68 x 19	Forest
8	12	2.61	100	261	2	2½	5	5	68 x 20	Forestay
10	16	5.44	75	408	2½	3	6	6	81 x 21	Forested

LARGER SIZES ON HAND OR TO ORDER AT SHORT NOTICE.

lering a pump, please answer the following questions:

her for hot or cold water? 2d. To what height is water to be lifted by suction? 3d. Length pe? 4th. Against what pressure or height is water to be forced? 5th. Amount of water our?

0, 1, 2, 3, 4, and 4½ pumps are provided with hand power attachments.

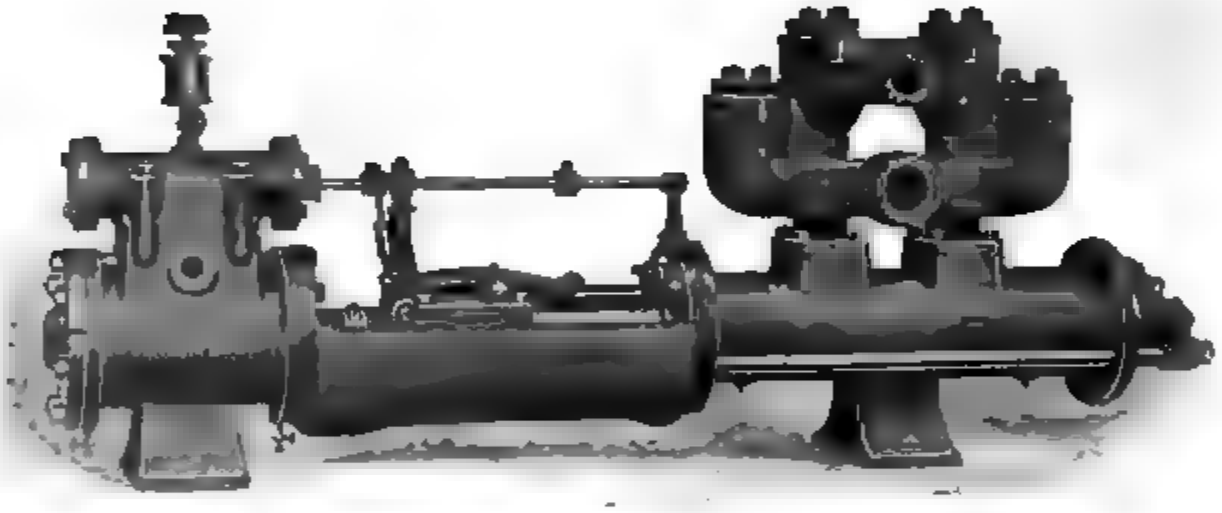
t Hand Power Attachment is invaluable, as the pump can be used, when steam is down, lers after "blowing off," washing decks, fire purposes, etc. The Hand Lever can be easily simply lifting it from the pump.

t recommend the use of copper air chambers, as experience has shown they are unreliable, pressures above 100 pounds. We will furnish copper air chambers, however, if required, to No. 10 inclusive, *at a slight additional* charge.

ount No. 000 and No. 00 are good for 250 feet lift, for mine use, or for 125 pounds pre

Sizes No. 000 and No. 00 are good for 200 pounds pressure.

[redacted]



KNOWLES PATENT PLUNGER PUMP.

Double-Acting.

KNOWLES PATENT

Plunger Pumps—Double Acting.

For Feeding Boilers, Pumping Water containing Sediment or Grit, etc.

Plunger pumps for boiler feeding, especially under the higher range of pressures, have certain antages over "piston" pumps. They are very efficient and remarkably durable—the only wearing in the pump end being the packing of the plunger stuffing boxes. No leak can occur there without g observed, and easily stopped by setting up the packing. The plunger not touching the pump ings, there is no cutting or wear, consequently they require no reboring or refitting, like piston ps, when working on gritty or sandy water.

As feed pumps, where very high steam pressure is carried (300 lbs. or less), the Knowles Plunger ps **have no equal.** They have a splendid record in places where the work is very severe and con- uous, such as found in rolling mills, blast furnaces, and sugar refineries. They are also particularly pted for pumping gritty or muddy water from mines, quarries, wells, pits, and similar places.

These pumps are very strong and compact. The piston rods do not enter the pump cylinders, and therefore not exposed to the action of the water. The plungers are connected by substantial side s and crossheads. The water valves are of special form, made of gun metal composition or rubber, ording to circumstances. There is a cover over each valve, giving quick and easy access to same.

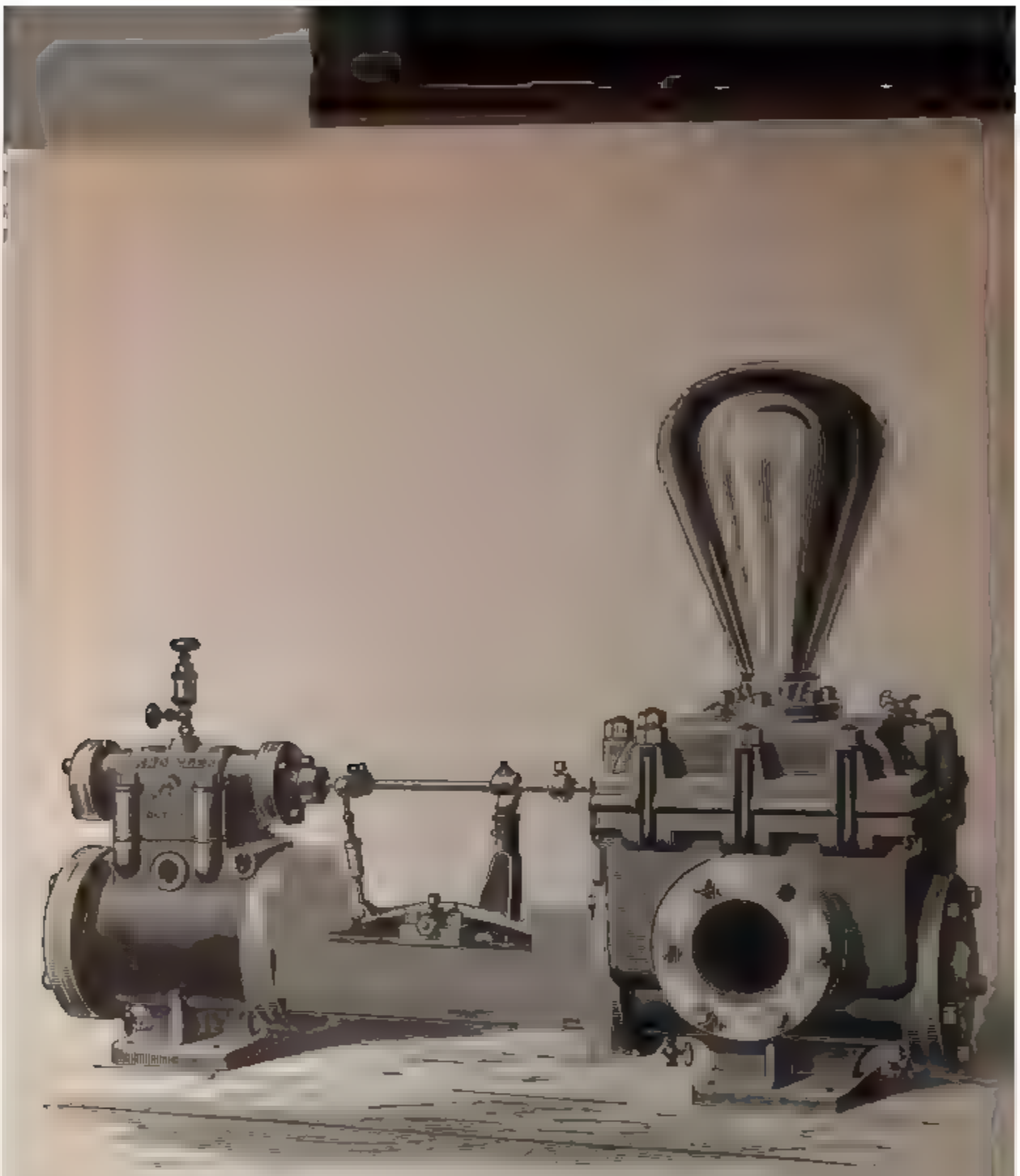
SIZES AND CAPACITIES.

ams under	Water Plungers.	Stroke.	Gallons per Stroke.	Capacity per Minute at Maximum Speed.		Steam Pipe.	Exhaust Pipe.	Suction Pipe.	Delivery Pipe.	Floor Space Required.	Telegraphic Code Word.
ins.	Ins.	Ins.		Strokes.	Gals.	Ins.	Ins.	Ins.	Ins.	Ins.	
4	2½	5	.11	150	16½	½	¾	1¼	1	57 x 10	Forewarn
5½	3¼	7	.25	125	31	¾	1	2	1½	72 x 12	Forewind
6	3¼	7	.33	125	42	¾	1	2	1½	72 x 12	Forewish
7½	4½	10	69	100	69	1	1¼	2½	2	92 x 12	Forfex
8	5	10	.85	100	85	1	1¼	3	2½	92 x 12	Forger
8	5	12	1.02	100	102	1	1¼	3	2½	112 x 12	Forgetful
10	6	12	1.47	100	147	1¼	1½	3½	3	112 x 22	Forgetting
12	6	12	1.47	100	147	2	2½	3½	3	114 x 22	Forgive
12	7	12	2.00	100	200	2	2½	5	4	120 x 27	Forgiving
14	7	12	2.00	100	200	2	2½	5	4	120 x 27	Forgotten
14	8	12	2.61	100	261	2	2½	5	4	124 x 27	Forkedly
16	8	12	2.61	100	261	2½	3	5	4	124 x 28	Forkhead
18	10	16	5.44	75	408	3½	4	8	6	164 x 30	Forkless

HEAVY PATTERN, FOR 300 LBS. WATER PRESSURE.

4½	3¼	10	.47	100	47	1	1¼	2	1½	92 x 12	Iberico
5	4	12	.65	100	65	1	1¼	2½	2	112 x 12	Ibexes
5	5	12	1.02	100	102	1	1¼	3	2½	112 x 12	Ibhar
7	5	12	1.02	100	102	1¼	1½	3	2½	112 x 12	Ibiapaba
9	6	12	1.47	100	147	1¼	1½	3½	3	112 x 22	Ibicara
10	6	12	1.47	100	147	2	2½	3½	3	114 x 22	Ibicencas
11	7	12	2.00	100	200	2	2½	5	4	120 x 27	Ibicinos
11	7	12	2.00	100	200	2	2½	5	4	120 x 27	Ibidion
13	8	12	2.61	100	261	2	2½	6	5	124 x 27	Ibilitaet
15	8	18	3.91	67	261	2½	3	6	5	164 x 30	Ibiracoa
15	9	18	4.96	67	332	2½	3	8	6	164 x 30	Ibiride
17	9	18	4.96	67	332	2½	3	8	6	172 x 30	Ibiscorum

All the working parts of these pumps are made to gauge, and are therefore interchangeable. Minute parts can be quickly substituted when old parts are worn or broken.



KNOWLES PATENT TANK PUMP.

For Light Service.

Size, 8 x 8 x 12.

KNOWLES PATENT

Tank or Light Service Pumps.

pumping water or other liquids to limited heights and distances these pumps possess special ages; they combine *large pumping capacity* with small expenditure of steam. The steam cylinders, ortion to the pump cylinders, are made smaller in diameter than with the regular pressure pumps, isequently the first cost is less—for *amount* of water pumped. These pumps are principally used oad water stations, gas and oil works, bleacheries, tanneries, refineries, plantations, distilleries, variety of valves are used adapted for pumping hot, cold, thick, thin, alkaline, or other liquids. **Quarries and Clay Pits**, also for coffer dams, tunnels, foundation pits, ore beds, sewerage, and ng purposes, these pumps are especially adapted, having large water passages and valve openings.

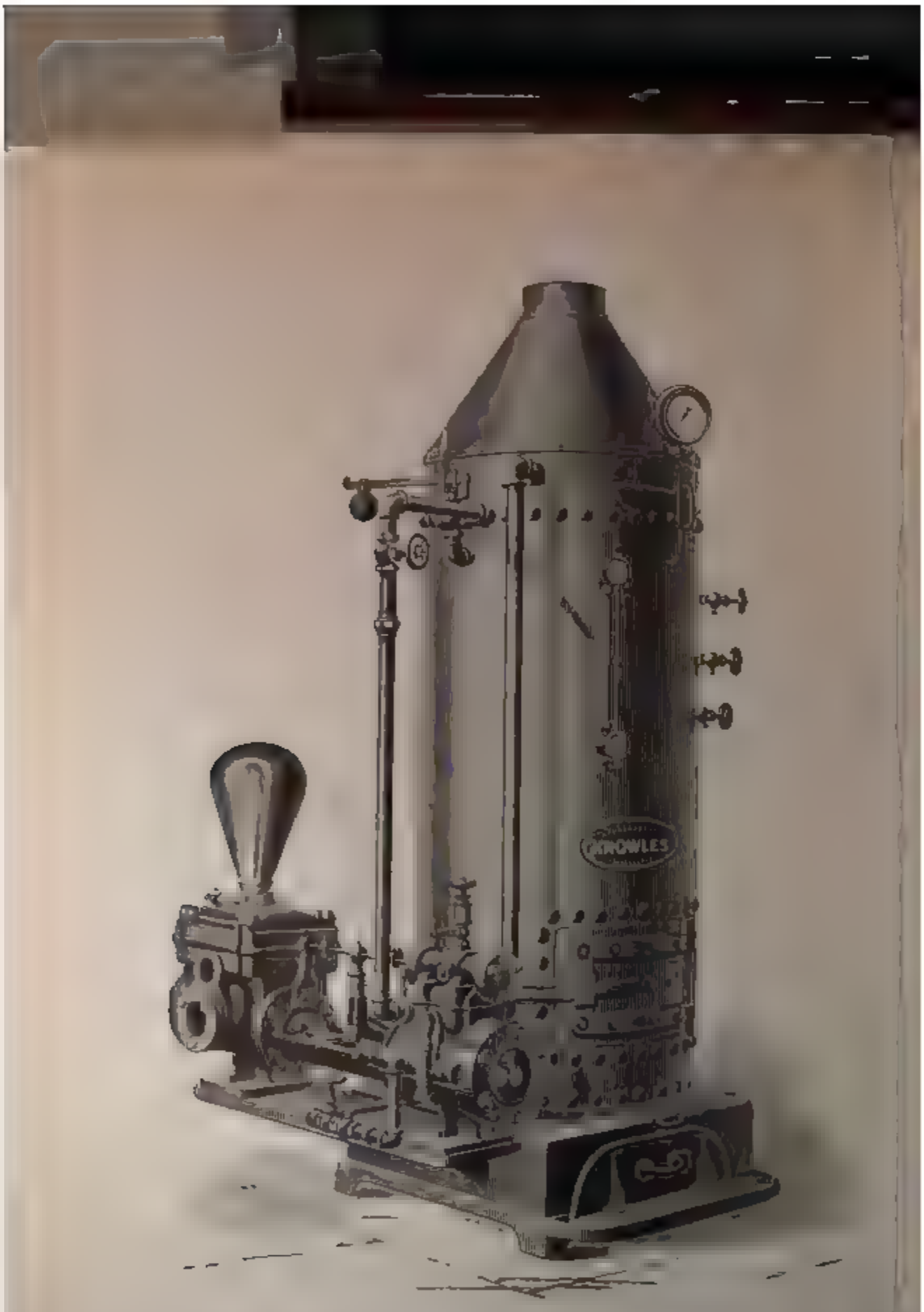
SIZES AND CAPACITIES.

Water Cylinder.	Stroke.	Gallons per Stroke	Capacity per Minute at Maximum Speed.		Steam Pipe.	Exhaust Pipe.	Suction Pipe.	Delivery Pipe.	Floor Space Required.	Telegraphic Code Word.
Ins.	Ins.		Strokes.	Gals.	Ins.	Ins.	Ins.	Ins.	Ins.	
3¼	4	.15	125	18	½	¾	2	1½	32 x 9	Forktail
4	5	.27	125	33	½	¾	2	1½	35 x 9	Forky
4	7	.39	125	49	¾	1	2½	2	44 x 9	Forlay
5½	7	.72	125	90	¾	1	3	2½	45 x 10	Forlie
5½	7	.72	125	90	¾	1	3	2½	45 x 13	Formal
6	12	1.47	100	147	¾	1	4	4	60 x 14	Formally
7	12	2.00	100	200	¾	1	5	5	66 x 14	Formate
7	10	1.66	100	166	1	1¼	5	5	56 x 14	Formerly
7½	10	1.91	100	191	1	1¼	5	5	56 x 14	Formful
6	12	1.47	100	147	1	1¼	4	4	66 x 14	Formic
7	12	2.00	100	200	1	1¼	5	5	66 x 14	Formill
8	12	2.61	100	261	1	1¼	5	5	66 x 15	Forpass
9	12	3.30	100	330	1	1¼	6	6	67 x 25	Forpine
10	12	4.08	100	408	1	1¼	6	6	67 x 25	Forsake
9	16	4.40	75	330	1¼	1½	6	6	89 x 25	Forsaking
10	12	4.08	100	408	1¼	1½	6	6	69 x 25	Forslack
10	16	5.44	75	408	1¼	1½	6	6	89 x 25	Forster
12	12	5.87	100	587	1¼	1½	8	6	69 x 25	Forswear
12	16	7.83	75	587	1¼	1½	8	6	89 x 28	Forswonk
10	12	4.08	100	408	2	2½	6	6	69 x 25	Forswore
10	16	5.44	75	408	2	2½	6	6	89 x 25	Forte
12	12	5.87	100	587	2	2½	8	6	70 x 25	Forthink
12	16	7.83	75	587	2	2½	8	6	89 x 28	Fortin
14	16	10.66	75	800	2	2½	10	8	89 x 28	Fortitude
12	12	5.87	100	587	2	2½	8	6	70 x 25	Fortlet
12	16	7.83	75	587	2½	3	8	6	89 x 28	Fortress
14	12	8.00	100	800	2	2½	10	8	78 x 28	Fortuitous
14	16	10.66	75	800	2½	3	10	8	89 x 28	Fortuity
14	24	16.00	50	800	2½	3	10	8	108 x 28	Forum
16	16	14.92	75	1020	2½	3	12	10	89 x 29	Forwaste
16	24	20.88	50	1044	2½	3	12	10	108 x 29	Forweary
14	16	10.66	75	800	2½	3	10	8	90 x 28	Forweep
14	24	16.00	50	800	2½	3	10	8	114 x 28	Fosse
16	16	14.92	75	1020	2½	3	12	10	96 x 29	Fossores
16	24	20.88	50	1044	2½	3	12	10	114 x 29	Fossroad
18	24	26.44	50	1322	2½	3	12	10	118 x 32	Fother
20	24	32.64	50	1632	2½	3	14	12	118 x 32	Fougade
16	24	20.88	50	1044	3½	4	12	10	118 x 29	Foughten
18	24	26.44	50	1322	3½	4	12	10	118 x 32	Foulder
20	24	32.64	50	1632	3½	4	14	12	118 x 32	Fouled
22	24	39.50	50	1975	3½	4	14	14	120 x 35	Fouling
24	24	47.00	50	2350	3½	4	16	16	132 x 39	Foulingly
18	24	26.44	50	1322	3½	4	12	10	128 x 32	Foully
20	24	32.64	50	1632	3½	4	14	12	128 x 32	Foumart
22	24	39.50	50	1975	3½	4	14	14	128 x 35	Founded
24	24	47.00	50	2350	3½	4	16	16	132 x 39	Fount

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

water cylinders are arranged with *composition* linings, valve seats, valve bolts, water pistons, ton rods; the water pistons are packed with a special form of adjustable packing.
tiliary Boiler Feed Pumps (single action plungers) attached when required. Prices extra. Pumps ater cylinders entirely of COMPOSITION, EXTRA. The hand-power attachment applied to the first es.

In ordering, parties will please state fully the duty to be performed, also size and length of pipes. sizes up to 8 x 8 x 12 *inclusive are of the* "flat cap" pattern, good for water pressures correspond- 80 feet *head or less. Larger sizes have* water cylinders of the "close clearance" type, suited for *ead, or less. Copper air chambers will be* furnished, if required, at a slight additional charge.



KNOWLES COMBINED BOILER AND PUMP.

Regular Upright Tubular Boiler.

[redacted]

KNOWLES PATENT

COMBINED BOILER AND PUMP.

(REGULAR UPRIGHT TUBULAR BOILER.)

mplete with Auxiliary Boiler Feed Pump, Base Plate, Smoke Bonnet, Grate Bars, Gauge Cocks, Steam Gauge, Water Gauge, Safety Valve, Globe Valves, Blow-off Cocks, Steam and Exhaust Pipes, Boiler Feed Connection, Valves, Unions and Necessary Fittings, etc.

'HIS combination of Knowles Improved Steam Pump with Upright Tubular Boiler and fixtures complete is the most compact, serviceable and inexpensive machine of its kind for supplying water to hotels, blic buildings and residences; also for use in railroad water stations, brick-yards, tanneries, quarries, etc.

The attention of railroad officials is particularly called to the especial advantage of this light, portable and venient pumping apparatus for the water supply of tanks at watering stations. The entire machine can placed at the point from which the water is to be taken, and the water forced to any distance and height uired.

It does not need a skilled mechanic in setting up or operating it. A person of ordinary intelligence can be ght its management in a few hours' time.

The whole apparatus is of the best manufacture, the boiler being perfectly safe and guaranteed to 100 lbs. ssure (tested to 200 lbs.) per square inch. When water is to be forced not higher than 50 to 75 feet, the Tank Pumps" are preferable and less expensive. Auxiliary Plunger Pumps for feeding the boilers are ached to the main pumps without additional charge.

SIZES, CAPACITIES AND PRICES:

Size No.	Steam Cylinder. Inches.	Water Cylinder. Inches.	Stroke. Inches.	Gallons per Stroke.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipe. Inches.	Delivery Pipe. Inches.	Floor Space Required. Inches.	Price, Complete
000	2½	1½	3	.023	¼	⅜	½	⅜	28 x 31	
00	3	1¾	3	.031	¼	⅜	¾	½	28 x 31	
0*	3¼	2	4	.05	½	¾	1¼	1	37 x 39	
1*	3⅝	2¼	4	.07	½	¾	1¼	1	38 x 40	
2*	4	2½	5	.11	½	¾	1¼	1	38 x 40	
3*	5	3¼	7	.25	¾	1	2	1½	40 x 44	
4*	5⅛	3¾	7	.34	¾	1	2	1½	40 x 44	
4½	7	4	7	.39	1	1¼	2½	2	40 x 46	
5	7	4½	10	.69	1	1¼	3	2½	54 x 58	
6	7⅛	5	10	.85	1	1¼	3	2½	56 x 58	
6½	8	5	12	1.02	1	1¼	4	4	58 x 58	
7	10	6	12	1.47	1¼	1½	4	4		
8	12	7	12	2.00	2	2½	5	5		
9	14	8	12	2.61	2	2½	5	5		
TANK PUMPS.										
	*4	4	5	.27	1½	¾	2	1½	38 x 40	
	*5⅛	5⅛	7	.72	¾	1	3	2½	40 x 48	
	6	6	12	1.46	¾	1	4	4	58 x 58	
	7⅛	7⅛	10	1.99	1	1¼	5	5	56 x 58	
	8	8	12	2.65	1	1¼	5	5	58 x 58	
	10	10	12	4.08	1¼	1½	6	6		
	10	10	16	5.43	1¼	1½	6	6		

LARGER SIZES, WITH UPRIGHT, HORIZONTAL, LOCOMOTIVE OR PATENT BOILERS, TO ORDER.

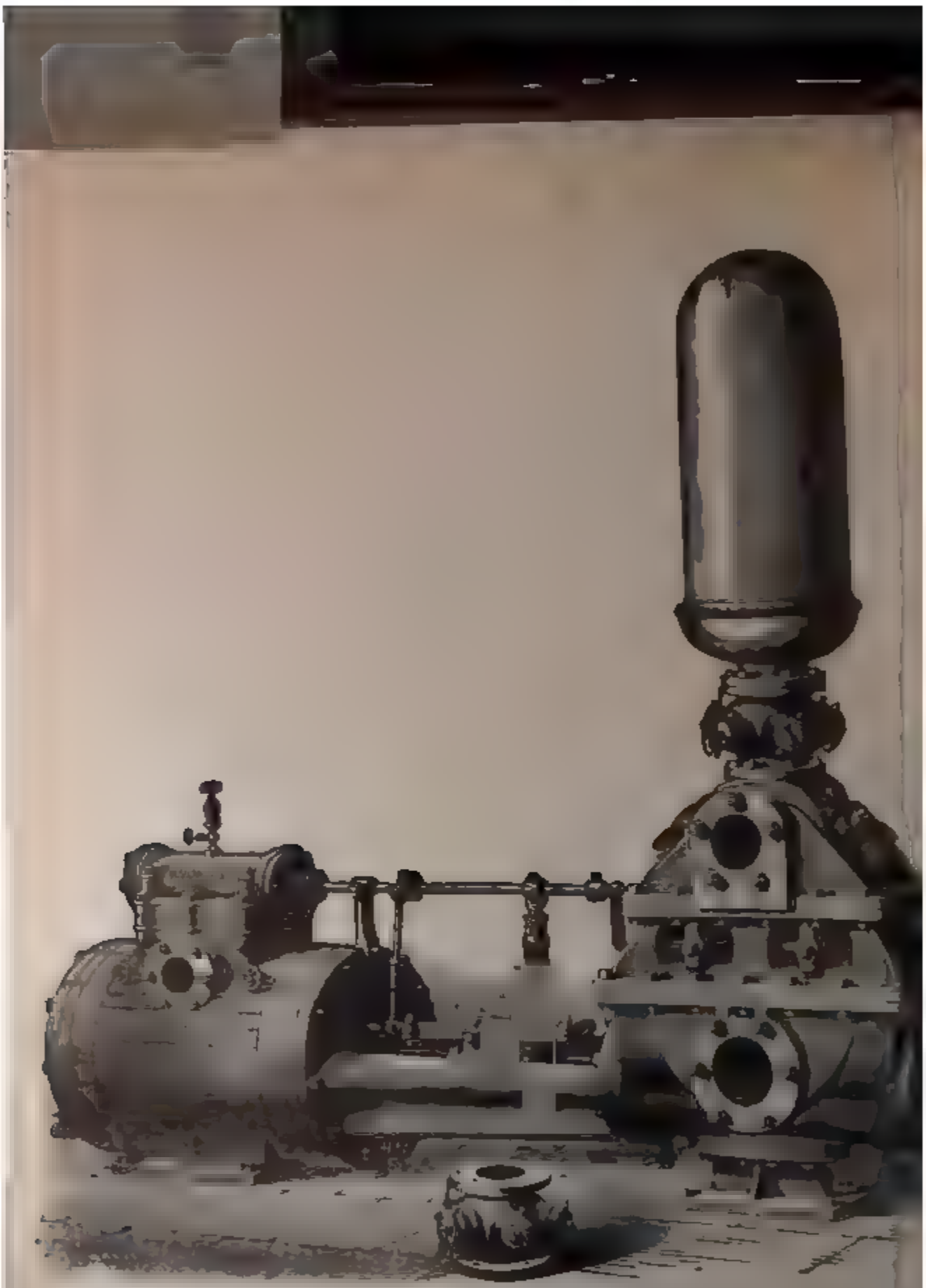
In setting up our Combined Boiler and Pump no trouble is liable to occur, as all the parts are carefully ted, properly numbered or marked, and every piece inspected before the apparatus is taken apart for shipment.

The pumps marked * are provided with our Patent HAND-POWER ATTACHMENTS, which are very convenient filling the boilers (after "blowing-off") or pumping when steam is down.

In ordering, parties will please state fully the particulars of duty to be performed.

EVERY MACHINE FULLY GUARANTEED.

☞ For PORTABLE Boiler and Pump mounted on wheels, see next two pages.



KNOWLES PATENT FIRE PUMP.

Double Cap Pattern.

The lagging on steam cylinder barrel, and the hose connection shown furnished only when ordered, at a slight additional expense.

KNOWLES PATENT

FIRE PUMPS—DOUBLE CAP PATTERN.

For Factories, Warehouses, Public Buildings, Coal Breakers, etc.

THESE pumps are built from special patterns embodying all the latest improvements. They are of superior design, construction and finish throughout. The castings are very heavy, and the various metals are distributed with a view to the greatest strength and durability. The water cylinders are lined and the valve seats, valve bolts, water pistons and piston-rods are made of the same metal. The water valves are of the best vulcanized rubber, and their springs of phosphor bronze; the valve plates are independent removable castings. The valve area and water passages are made very large to admit of high piston speed—an important feature! The steam valve chest is fitted with our Patent Composition Jacket, which effectually prevents the sticking of the valve by corrosion, or from unequal expansion, and insures the *instant starting* of the Pump, even after months of disuse.

SIZES, CAPACITIES AND PRICES:

Size.	Steam Cylinder. Inches.	Water Cylinder. Inches.	Stroke. Inches.	Gall'ns per Stroke	* Capacity per Minute at Ordinary Speed.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipe. Inches.	Delivery Pipe. Inches.	†Distance Streams Thrown. Feet.	Floor Space Required. Inches.	Price.
A	10	5	12	1.02	102 gals.	1¼	1½	4	4	150	67 x 36½	
AA	12	5	12	1.02	102 "	2	2½	4	4	175	67 x 36½	
B	12	6	12	1.47	147 "	2	2½	4	4	175	67½ x 36½	
BB	14	6	12	1.47	147 "	2	2½	4	4	200	67½ x 36½	
C	14	7	12	2.00	200 "	2	2½	5	5	200	69½ x 38½	
CC	16	7	12	2.00	200 "	2½	3	5	5	200	69½ x 20¾	
D	16	8	18	3.91	261 "	2½	3	6	6	200	75 x 20¾	
DD	18	8	18	3.91	261 "	2½	3	6	6	225	78 x 23	
E	18	9	24	6.60	330 "	2½	3	6	6	225	108 x 23	
EE	20	9	24	6.60	330 "	2½	3	6	6	250	108 x 25½	
F	20	10	24	8.16	408 "	2½	3	6	6	225	108 x 25½	
FF	22	10	24	8.16	408 "	3	3½	6	6	250	108 x 28	
G	24	12	24	11.75	587 "	3	4	8	6	225	109 x 30	
GG	26	12	24	11.75	587 "	3½	4	8	6	250	109 x 34	
H	28	14	24	16.00	800 "	4	4½	10	8	225	111 x 36	
HH	30	14	24	16.00	800 "	4	5	10	8	275	111 x 39½	
I	32	16	24	20.88	1044 "	4½	5	12	10	225	114 x 40½	
II	34	16	24	20.88	1044 "	4½	5	12	10	250	114 x 41½	
J	36	18	24	26.44	1322 "	4½	5	12	10	225	114 x 42	
JJ	38	18	24	26.44	1322 "	5	6	12	12	250	114 x 44	
K	42	20	36	48.96	1632 "	5	6	14	12	250	165 x 48	
SHORT STROKE.												
L	16	8	12	2.61	261 gals.	2½	3	5	5	200	69½ x 20½	
M	18	9	16	4.40	330 "	3½	4	6	6	200	84 x 25½	
N	20	10	16	5.44	408 "	3½	4	6	6	225	84 x 25½	
NN	22	10	16	5.44	408 "	4	4½	6	6	250	84 x 28	

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

* This column gives the capacity of each pump at the rate of 100 feet piston travel per minute. This speed can be increased in case of emergency.

† This gives approximately the distances that streams can be thrown *horizontally* with moderate steam pressure; the *vertical* distance would be about twenty-five per cent less. For further particulars see table of "Fire Streams" on page 121.

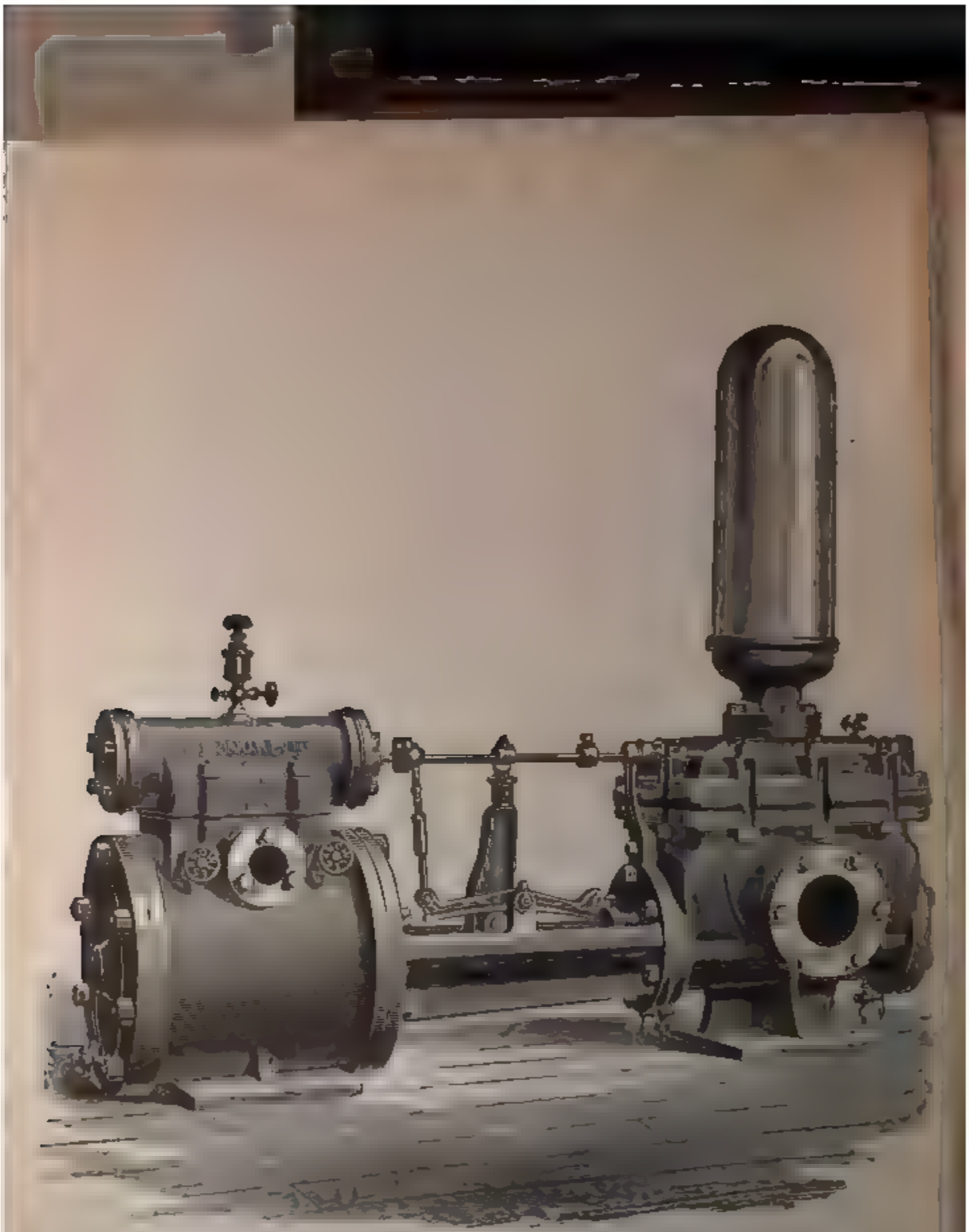
Each pump has suction and discharge openings on *both* sides, consequently connections can be made on either side desired. In addition to the regular discharge outlets, we furnish, when required, two, four and six way hose connections, as shown in opposite illustration, at a slight additional cost.

☞ INDEPENDENT STATIONARY FIRE APPARATUS, with "quick steaming" boilers, pipes, etc., adapted for towns and villages, factories, grain elevators, store-houses, public buildings, etc.

IMPROVED AUTOMATIC PUMP REGULATOR.

For operating fire pumps on the automatic system (where they are kept continually under steam pressure) we furnish an Improved Regulator which maintains any desired water pressure upon the pipes. This regulator is positive in its action, and very sensitive, shutting off the steam and stopping the pump when the desired pressure has been reached, and again starting it on the slightest reduction of the pressure. Prices as follows:—For 1 inch steam pipe, 1¼ inch, 1½ inch, 2 inch, 2½ inch, 3 inch, 3¼ inch, 4 inch.

RUBBER AND LINEN HOSE, HOSE PIPES, COUPLINGS, STRAINERS, ETC., at lowest rates.



KNOWLES PATENT MINING PUMP.

Regular Flat Cap Piston Pattern. Size No. 10.

KNOWLES PATENT

MINING PUMPS.

REGULAR PISTON PATTERN.

THE reputation of the Knowles Mining Pump, both at home and abroad, as the STANDARD pump for every class of mining work, has been well merited; it has always been recognized as the *best constructed* as well as the best designed pump in the market.

The duty to be performed by pumps in most mines is of necessity very severe and exacting. It is therefore an important requisite that pumps should be very durable, very simple, and at the same time *economical* in the use of steam. All these qualities are possessed in a marked degree by the

IMPROVED KNOWLES MINING PUMPS.

They require less attention and less repairs than any other make of pumping engines. They are the favorite mining pumps in the coal districts of Pennsylvania, where the worst water possible is pumped, and in the gold and silver mines of the Western States and Mexico, where the highest lifts are worked.

The new valve motion and general arrangement of the steam cylinders of these pumps have been brought to such a degree of perfection that they will work on the heaviest duty absolutely

WITHOUT SHOCK OR JAR ON PUMPS OR PIPES.

The engraving on the opposite page represents one of the Knowles Mining Pumps of the REGULAR PISTON PATTERN. This pump is adapted for ordinary work, where the water is usually free from grit and fine, and not too strongly impregnated with sulphurous or other acids. The design of the pump shown is one of strength, compactness and durability. In these pumps the water cylinders have large valve areas and passages. The water valves are easy of access and can be readily removed and duplicated — like all the working parts of these pumps — with little trouble and expense in case of wear or accidental breakage. The linings, piston-rods, valve seats, valve bolts and other parts coming in contact with the mine water are made of the best gun-metal composition. The water pistons are also made of gun-metal composition and are packed with fibrous packing set out by adjustable set screws and nuts.

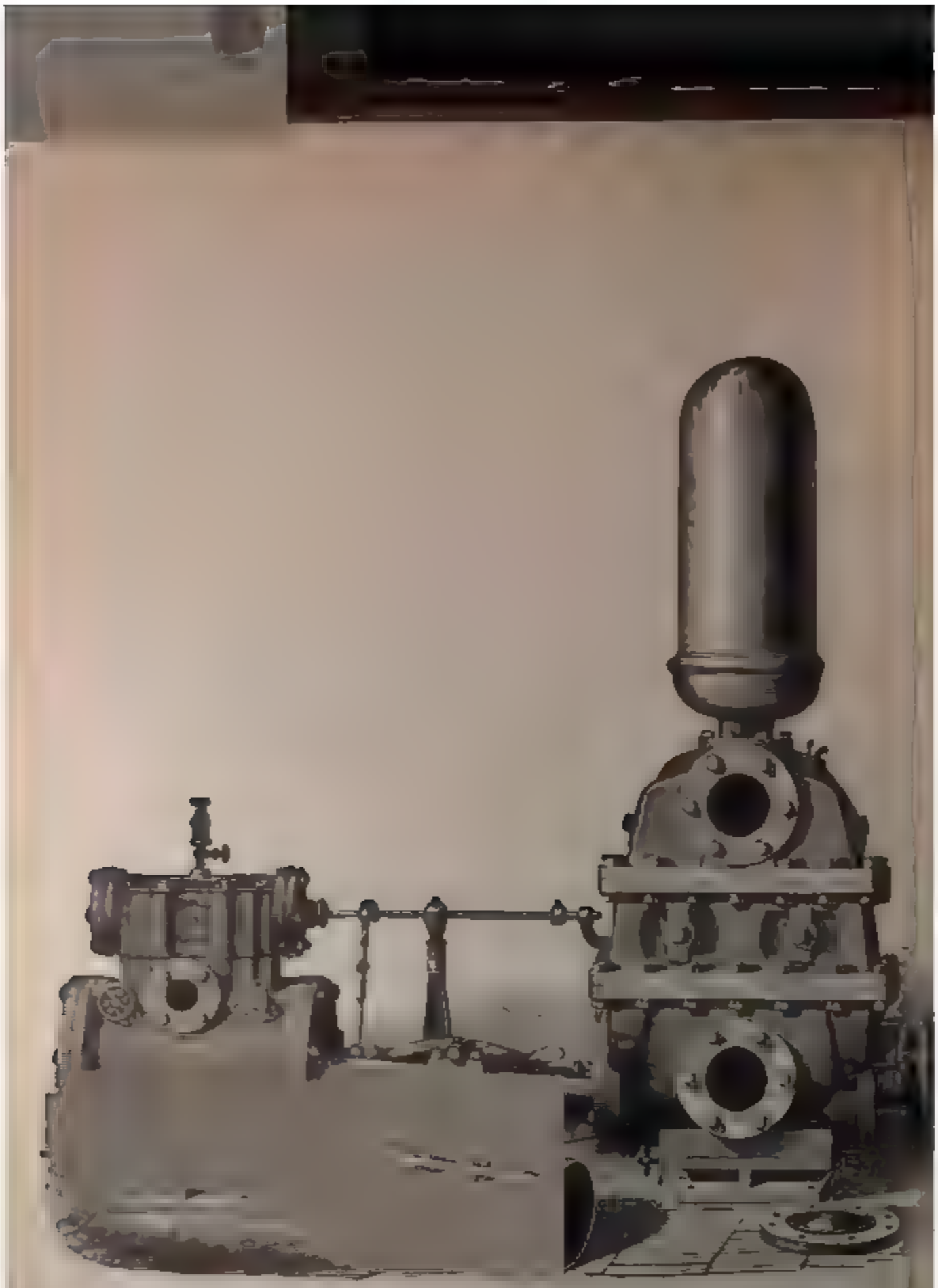
For full list of sizes and prices of these pumps, refer to page 27.

EVERY PUMP FULLY WARRANTED.

Piston Mining Pumps, arranged with *Patent Removable Cylinders*, see next two pages.

GUN-METAL COMPOSITION PUMPS.

There are many mines where the water is so impregnated with sulphurous or other acids as to require the pumps to be made with the water cylinders cast entirely of gun-metal composition. We have special patterns for this purpose, and only charge the additional cost for the composition.



KNOWLES PATENT MINING PUMP.

Double Cap Pattern, with Removable Cylinder.

KNOWLES PATENT

MINING PUMPS—CONTINUED.

REMOVABLE CYLINDER PATTERN.

WHERE mine water is very gritty and it is found that the use of a *plunger* pump (the style of pump usually used for bad water) is prohibited on account of limited room or other adverse circumstances, a piston pump must be used. In order to secure the greatest possible durability with this form of pump, we arrange the water cylinder with our patent

UNIVERSAL REMOVABLE CYLINDER

or pump barrel, which can be easily taken out and replaced by a new one when necessity requires it.

This patent removable cylinder can be partially turned in the pump, so that as the bottom part is cut or worn (this is the point of usual wear) a new surface can be brought into position, and thus the wear distributed over every portion of the bore of the cylinder. Finally, after the removable cylinder has served its purpose fully, a new one can be readily substituted without interrupting the pumping over ten minutes' time.

Another advantage of the *removable cylinder* feature is, that if it becomes necessary to place the pump lower in the mine—thus increasing the head to be pumped against—the original "REMOVABLE CYLINDER" can be changed for one of smaller bore, and so enable the pump to be continued in use.

The removable cylinder is a substantial casting of gun-metal composition, the design of which is shown in the opposite engraving. The valve-seats of the pump are of gun-metal composition; also the valve bolts, piston-rods, and water piston are made of gun-metal composition—this last being packed with patent fibrous packing set out by adjustable bolts and check nuts. The valves are of best vulcanized rubber or other material, and are easily reached by conveniently arranged hand-hole plates. The valve areas and water passages are large and free.

As the steam valves of the Knowles Mining Pumps are perfectly *positive*, they will always start on admission of steam—in fact, these

PUMPS WILL WORK UNDER WATER,

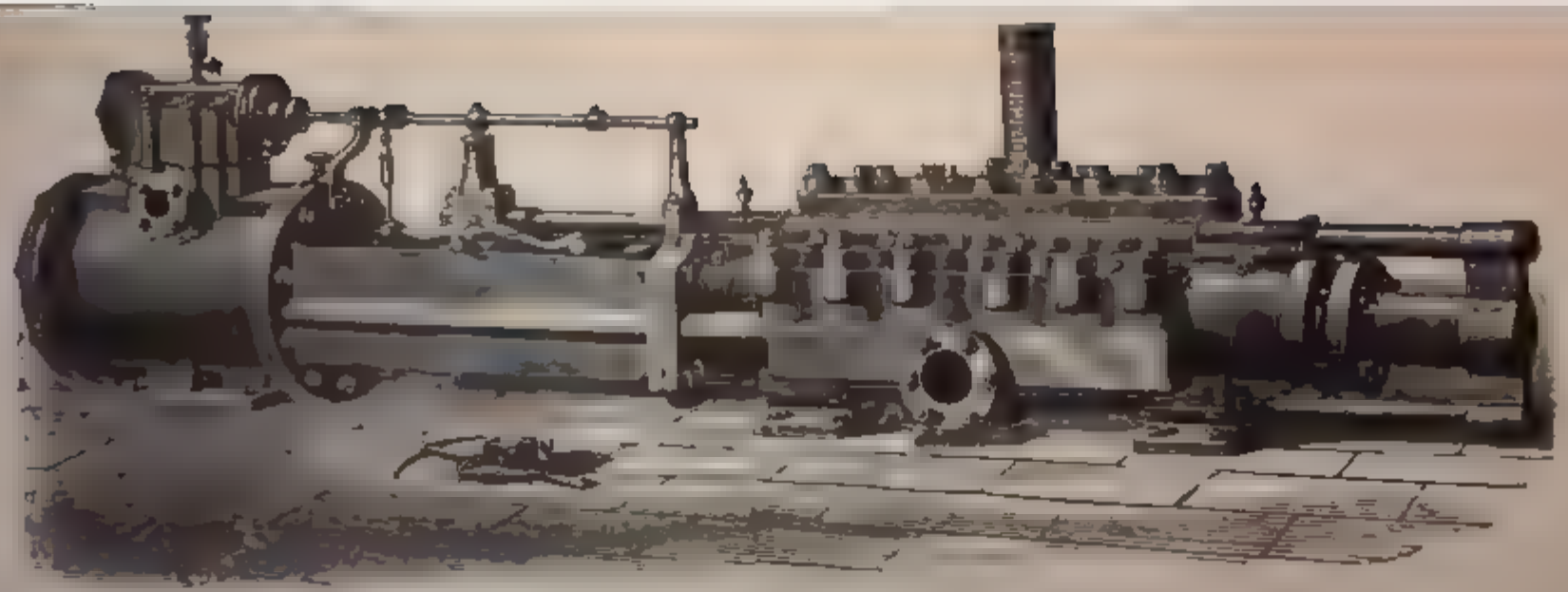
and clear themselves and the mine of water, whether steam, air or water is used in the steam cylinder. This is an important feature in case a mine becomes "drowned out."

Every pump before it is shipped from our factory is subjected to a rigorous test of hours' duration, under the heaviest pressure, consequently we are enabled to give a full guarantee with each and every pump sold.

☞ Sizes and prices of above REMOVABLE CYLINDER Piston Pumps will be found on page 27.

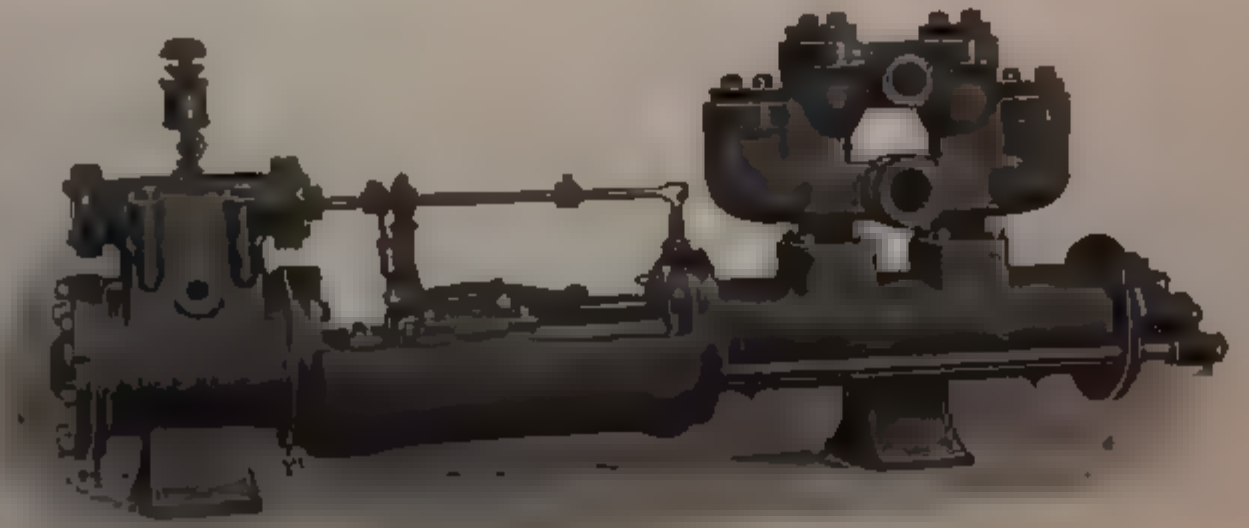
DOUBLE PLUNGER MINING PUMPS described on next two pages.

VERTICAL SINKING PUMPS, see pages 32 to 33-B.



KNOWLES PLUNGER MINING PUMP.

PATENT SOLID CYLINDER PATTERN.



KNOWLES PLUNGER MINING PUMP.

PATENT "PUT-VALVE" PATTERN

KNOWLES PATENT
MINING PUMPS—CONTINUED.

DOUBLE-PLUNGER PATTERN.

PLUNGER pumps have always been held in high esteem by users of mining machinery, for they are the most satisfactory pumps, all things considered, especially where the water is bad and the pressure heavy. The Knowles Plunger Mining Pumps combine all the advantages of the best designs of this class of pumps, while they possess original features which place them in point of excellence beyond anything of the kind that is built in this or any other country.

FOR HEAVY DUTY, especially in coal mine work where the water is likely to be strongly impregnated with acid, we construct these pumps of the hardest iron it is possible to work, making the metal from *two to three inches thick*, and all water passages equal in area to the plungers. This form of pump, supplied with water valves of special form, working on seats made entirely of gun-metal composition, is almost indestructible in bad water. *These features will be appreciated by every mining engineer.*

In each of the engravings opposite it is shown that there are two single-acting plungers attached to strong cross-heads by heavy rods of wrought iron; The piston-rod does not enter the pump cylinder, and is therefore not exposed to the action of the mine water. The plungers have outside stuffing-boxes which can be readily packed, and, being in sight, any leakage of water through the glands can be quickly detected. The plungers not passing through any sleeve or stuffing-box in center of cylinder, but being "outside connected," it is not possible for any water to leak by or to pass from one end of the cylinder to the other; the *displacement* of water at each stroke is exactly *equal*. The first engraving opposite represents

KNOWLES PATENT SOLID CYLINDER PATTERN.

This special form of mining pump is original with us and has many advantages not found in other forms of plunger pumps. It is especially adapted for the heaviest work,

The heavy castings, absence of joints and peculiar arrangement of valves and plungers, render this pump *exceedingly* durable. Practically, the only wearing point in the entire water end is the packing in the stuffing-boxes

The lower engraving opposite represents

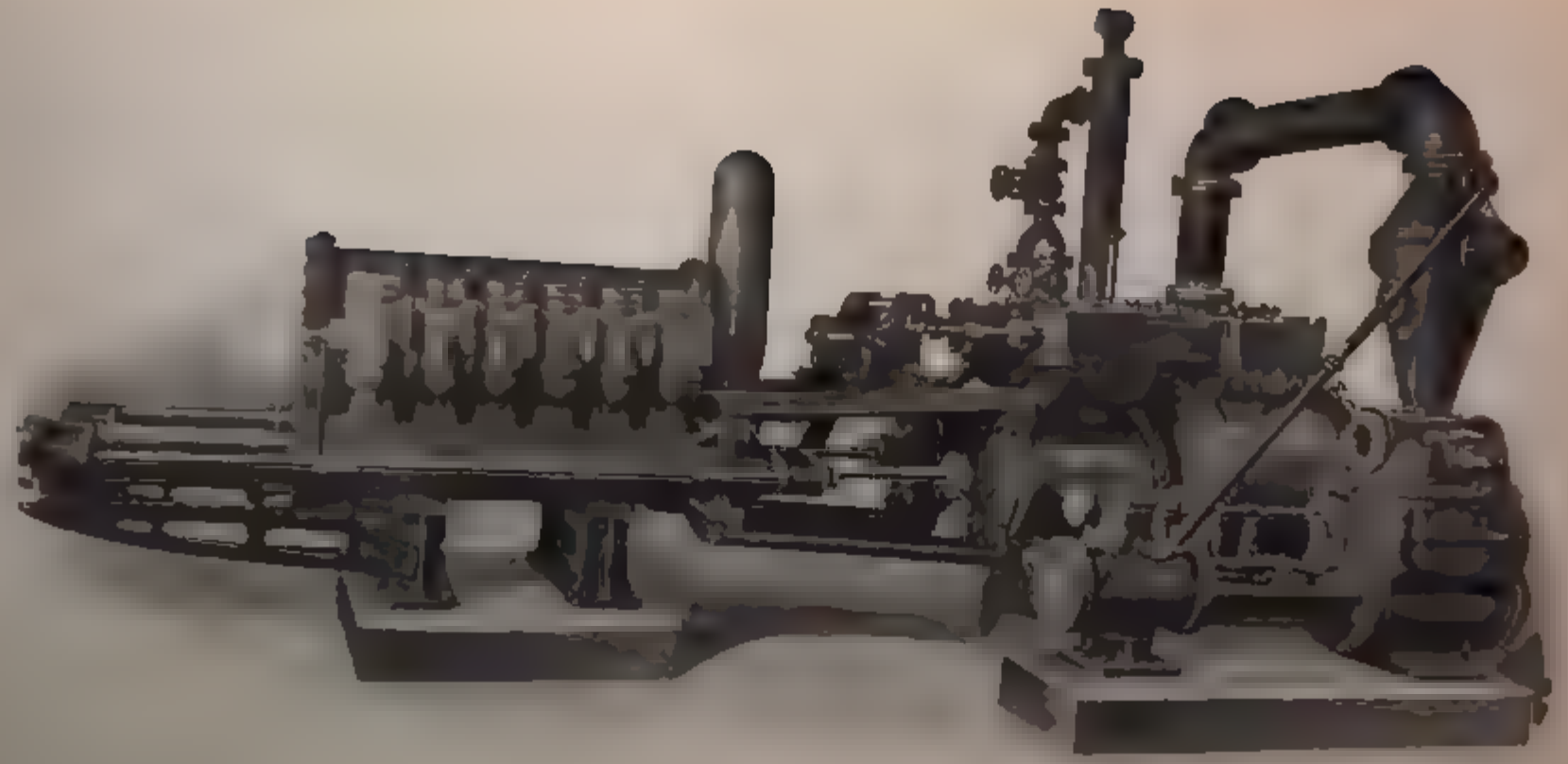
KNOWLES PATENT "POT-VALVE" PATTERN.

This form of mining pump differs from the above only in the arrangement of water valves, which (as the engraving shows) are enclosed in heavy "pots." These valves are of special design (patented) and possess the double advantage of quiet action and great durability. The valves work on *gun-metal composition seats;* the valves and seats can be readily taken out in one movement after the covers of the "pots" are removed. The "Pot-Valve" form of mining pumps is one that has long been popular with old mining engineers.

We have complete patterns for every size of both of the above styles of Improved Plunger Mining Pumps. See list of sizes and prices on next two pages. Prices on Pot Valve Pumps on application.

Compound Condensing *Plunger* Mining Pumps, see pages 28 and 29.

VERTICAL *Plunger* Sinking Pumps, see pages 33-A and 33-B.



KNOWLES "SPECIAL" COMPOUND CONDENSING DUPLEX MINING PUMP.

[illegible]

With Independent Air Pump and Condenser

For description see page [illegible]

[redacted]

KNOWLES PATENT
MINING PUMPS—CONTINUED.

TABLE OF SIZES.

perience in building pumps for mines in all parts of the world has proved that no one form of ing engine can fully meet the requirements of mines in different sections, or of those in the same rking under different conditions. Consequently we have, at great expense, designed and constructed different styles, which we fully describe in this catalogue, believing that THEY FULLY COVER IREMENTS of the various mines.

ble below gives the principal sizes of the three standard types of our Horizontal Mining Pumps, viz.:
AR PISTON PATTERN, as described on pages 20 and 21.
ABLE CYLINDER PATTERN, as described on pages 22 and 23.
E PLUNGER PATTERN, as described on pages 24 and 25.

SIZES AND CAPACITIES.

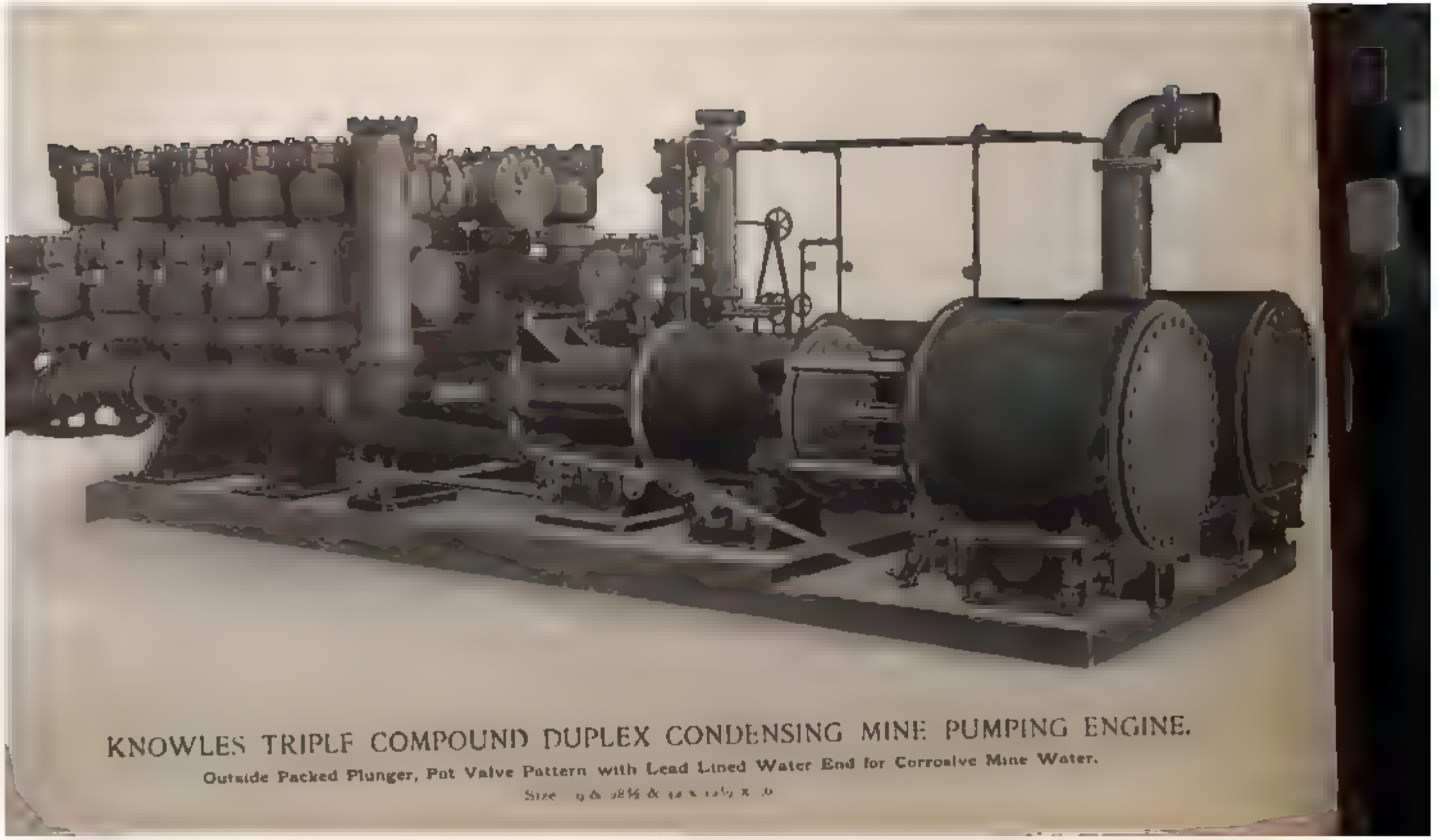
Water Cylinder or Plungers.	Stroke	Gallons per Stroke.	Capacity per Minute at Ordinary Speed.		Steam Pipe.	Exhaust Pipe.	Suction Pipe.	Delivery Pipe.
Inches.	Inches.				Inches.	Inches.	Inches.	Inches.
3	7	.22	125 Strokes,	28 Gallons	¾	1	2	1½
3¼	7	.34	125 "	42 "	¾	1	2	1½
3¼	10	.36	100 "	36 "	1	1¼	2	1½
3¼	10	.47	100 "	47 "	1	1¼	2½	2
4½	10	.69	100 "	69 "	1	1¼	3	2½
4	12	.65	100 "	65 "	1	1¼	3	2½
4½	12	.82	100 "	82 "	1	1¼	3	2½
5	10	.85	100 "	85 "	1	1¼	3	2½
5	12	1.02	100 "	102 "	1	1¼	4	4
4	12	.65	100 "	65 "	1¼	1½	4	4
4½	12	.82	100 "	82 "	1¼	1½	4	4
5	12	1.02	100 "	102 "	1¼	1½	4	4
6	12	1.47	100 "	147 "	1¼	1½	4	4
5	12	1.02	100 "	102 "	2	2½	4	4
6	12	1.47	100 "	147 "	2	2½	4	4
7	12	2.00	100 "	200 "	2	2½	5	5
8	12	2.61	100 "	261 "	2	2½	5	5
5	12	1.02	100 "	102 "	2½	3	4	4
6	12	1.47	100 "	147 "	2½	3	4	4
7	12	2.00	100 "	200 "	2½	3	5	5
7	16	2.67	75 "	200 "	2½	3	5	5
8	12	2.61	100 "	261 "	2½	3	5	5
8	16	3.48	75 "	263 "	2½	3	5	5
7	16	2.67	75 "	200 "	2½	3	5	5
7	24	4.00	50 "	200 "	2½	3	5	5
8	16	3.48	75 "	263 "	2½	3	5	5
8	24	5.22	50 "	263 "	2½	3	5	5
9	16	4.44	75 "	332 "	2½	3	6	6
9	24	6.60	50 "	332 "	2½	3	6	6
10	16	5.33	75 "	410 "	2½	3	6	6
10	24	8.16	50 "	410 "	2½	3	10	8
8	16	3.48	75 "	263 "	2½	3	5	5
8	24	5.22	50 "	263 "	3½	4	5	5
9	16	4.44	75 "	332 "	2½	3	6	6
9	24	6.60	50 "	332 "	3½	4	6	6

ALSO PATTERNS FOR LARGER SIZES AND OTHER COMBINATIONS OF CYLINDERS.

ering, purchasers should be specific in giving information as to the conditions under which the pumps rate, that we may be able to do full justice to ourselves and give entire satisfaction. They should also her the water is clear or gritty, and particularly if it is impregnated with sulphurous or other corroding it is necessary to arrange the pumps with

GUN-METAL COMPOSITION WATER CYLINDERS

pecial patterns for this purpose, charging only for the additional cost of the composition metal.



KNOWLES TRIPLE COMPOUND DUPLEX CONDENSING MINE PUMPING ENGINE.

Outside Packed Plunger, Pot Valve Pattern with Lead Lined Water End for Corrosive Mine Water.

Size [illegible]

KNOWLES PATENT

MINING PUMPS—CONTINUED

COMPOUND CONDENSING DUPLEX PLUNGER PUMPS.

With Independent Air Pump and Condenser.

WE are furnishing many of the deep mines of this country and Mexico with the Knowles Improved Compound Condensing Plunger Mining Pumps, complete with Independent Air Pumps and Condensers. This improved type of direct-acting pumping machinery is becoming very popular among mining engineers, as the greatest simplicity and efficiency are combined with

HIGHEST ECONOMY IN USE OF FUEL.

Like the best types of modern (compound) steam engines, these improved pumping engines are arranged with high and low pressure steam cylinders—the steam, after being used in the former, is expanded into the latter, and utilized a second time before it goes to the condenser. The Independent Air Pump is compact and very efficient, giving the highest vacuum desired. The injection water for the condenser is drawn from the "sump" or tank, from which the main pump takes its supply. The warm water discharged by the air pump is carried to a point close to the suction pipe of the main pump.

Briefly stated, the Knowles Compound Condensing Plunger Mine Pumps possess the following advantages over the more cumbersome and complicated "Cornish" or Rotative pumping engines, viz.:

a.—The first cost is from 30 to 50 per cent less.

b.—In transportation and in erection the expense is less than half.

c.—Do not require massive and expensive foundations or large buildings.

d.—There are no pump rods, guides, rollers, "bobs" or other parts to produce excessive friction, get out of order and wear out.

e.—Require less attendance, as there are so few working parts; also require less expense for oil, waste and similar supplies. Take up considerably less of the room in the shaft.

f.—As they are double-acting in operation, the column of water is kept continually in motion, thereby relieving pipes and pumps from *shock and jar*, and avoiding leaky joints in column pipe.

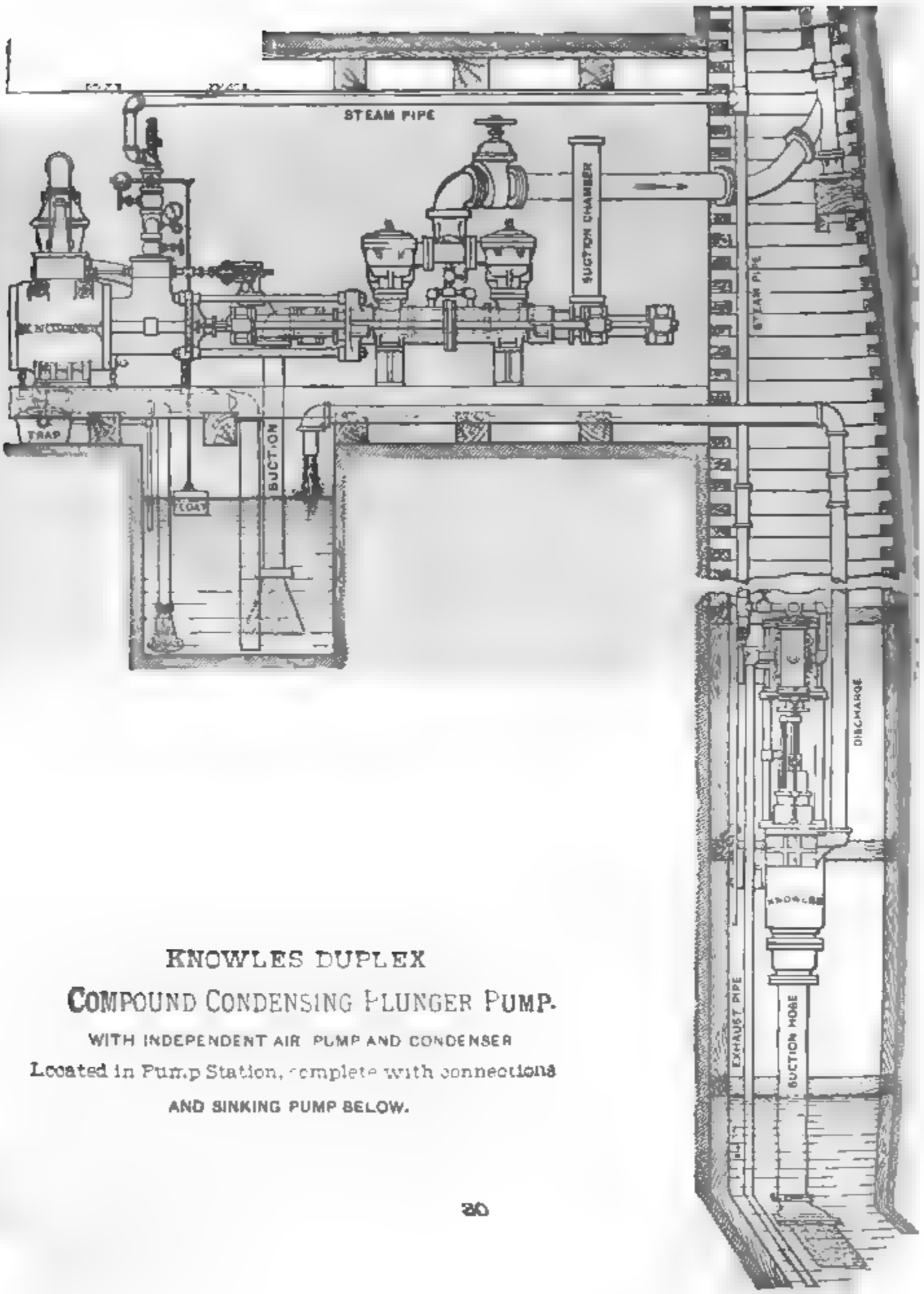
g.—Smaller column pipes can be used, as the water is not intermittent in its flow, consequently the outlay for column pipe is very much less—an important item of saving.

h.—Can pump the water in lifts of greater height, as it is only necessary to proportion the power of the steam cylinders to the load on the water plungers. (We have many of these pumps pumping as high as 1000 feet vertically in *one* lift.)

The engraving on opposite page illustrates one of our Triple Compound Duplex Condensing Mining Pumps, having a capacity of 1,500 gallons per minute and of sufficient power and strength to elevate the water in one lift 850 ft. in height.

When the mine water to be handled is extremely corrosive these pumps may be fitted with lead lined pump ends, and with plungers covered with Babbitt metal. The increase in first cost is much more than offset by the prolonged life of the pump.

Estimates and further particulars on application.



KNOWLES DUPLEX
COMPOUND CONDENSING PLUNGER PUMP.

WITH INDEPENDENT AIR PUMP AND CONDENSER

Located in Pump Station, complete with connections

AND SINKING PUMP BELOW.

KNOWLES PATENT
MINING PUMPS—CONTINUED.

COMPOUND CONDENSING DUPLEX PLUNGER PUMP

WITH INDEPENDENT AIR PUMP AND CONDENSER,

LOCATED IN PUMP STATION, COMPLETE WITH CONNECTIONS,

WITH SINKING PUMP BELOW.

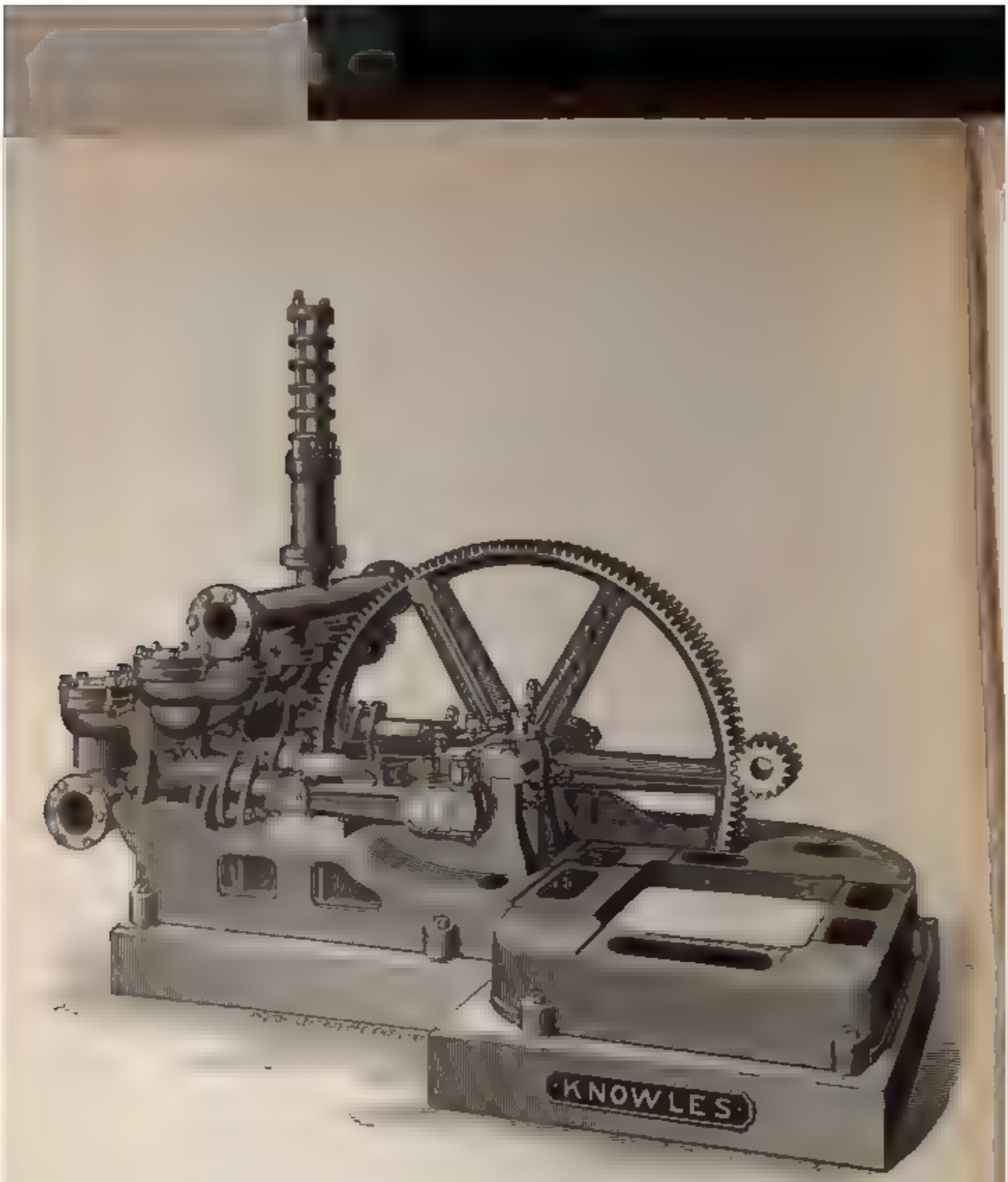
THE cut on opposite page is from a drawing representing the 800 foot pump station of a mine, with the Knowles Compound Condensing Duplex Pumping Engine in place, and the Sinking Pump in position below the station. This pumping engine is fully described on the preceeding pages, i.e. pages 28 and 29 The Vertical Sinking Pump is shown and described on pages 32 to 33-B.

In deepening the shaft the Sinking Pump is lowered at intervals as the excavation progresses. The water at the bottom of the shaft is taken by the sinking pump and delivered to the tank or sump that supplies the pumping engine in the station. A single steam pipe down the shaft supplies both the pumping engine and sinking pump. The exhaust steam from the pumping engine, as before explained, is condensed by the Independent Air Pump and Jet Condenser. The exhaust steam from the sinking pump, however, is usually carried to the sump or into a special connection arranged on the suction nozzle of the sinking pump. This connection is a neat and inexpensive condensing arrangement (not shown in the cut) and does away with the exhaust steam-pipe in the shaft.

With a pumping plant similar to that described, mines can be sunk to any depth desired, or flooded mines recovered with the greatest facility and security. For mines of extreme depth it has been found advisable to put pumping stations, similar to that shown on page 30, at every 500 to 600 feet distant apart, although this distance can be increased to 800 or 1,000 feet, when desired. By this system, the Compound Condensing Pumping Engine in the lower station delivers to the next above (which is a duplicate of same) and so on to the surface. Below the lowest pump station is placed the sinking pump, as referred to above. Generally these sinking pumps are duplicated, for convenience and security. A mine thus equipped has the most reliable, simple, economical and complete pumping machinery known in modern mining p actice.

The cut opposite is taken from drawings of pumps in actual work, to which further reference will be gladly given when desired.

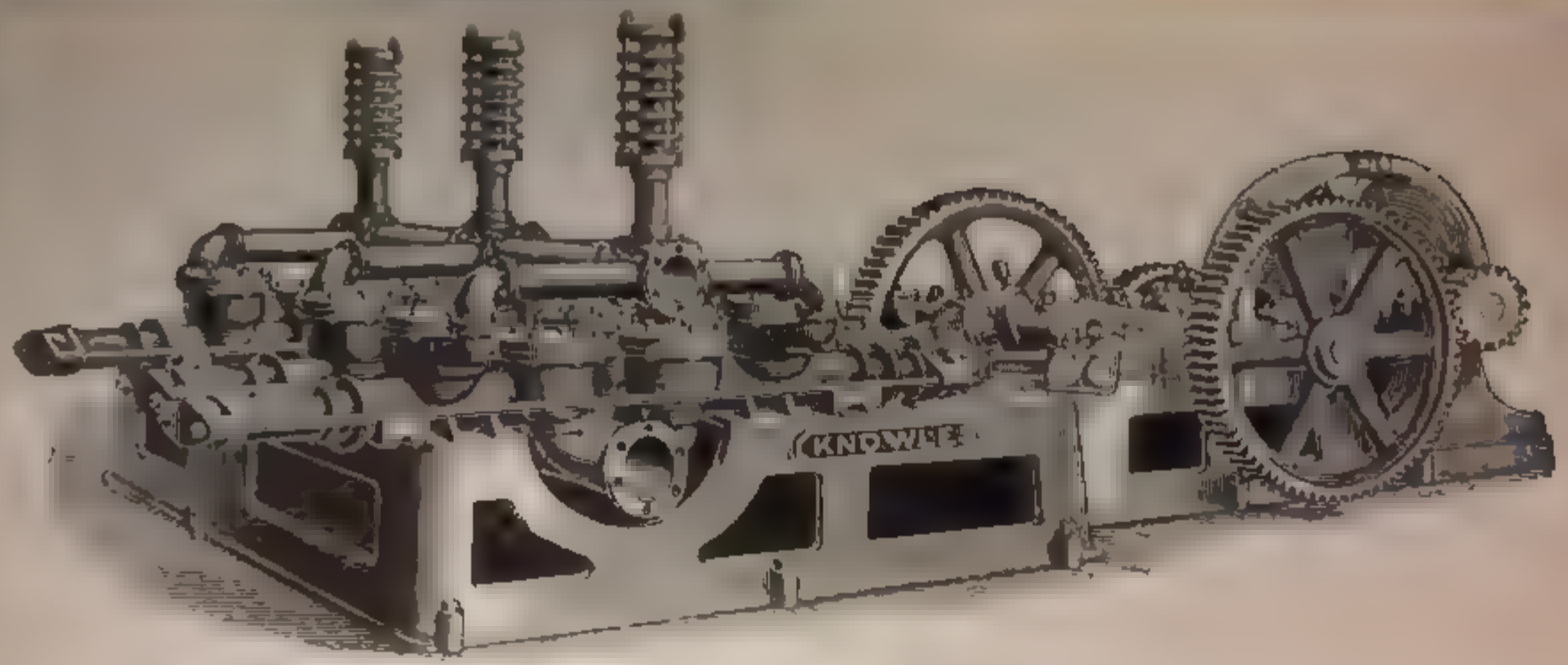
Estimates, plans and full particulars on application.



HORIZONTAL TRIPLEX ELECTRIC POWER PUMP.

With Single Acting Outside Packed Plungers.

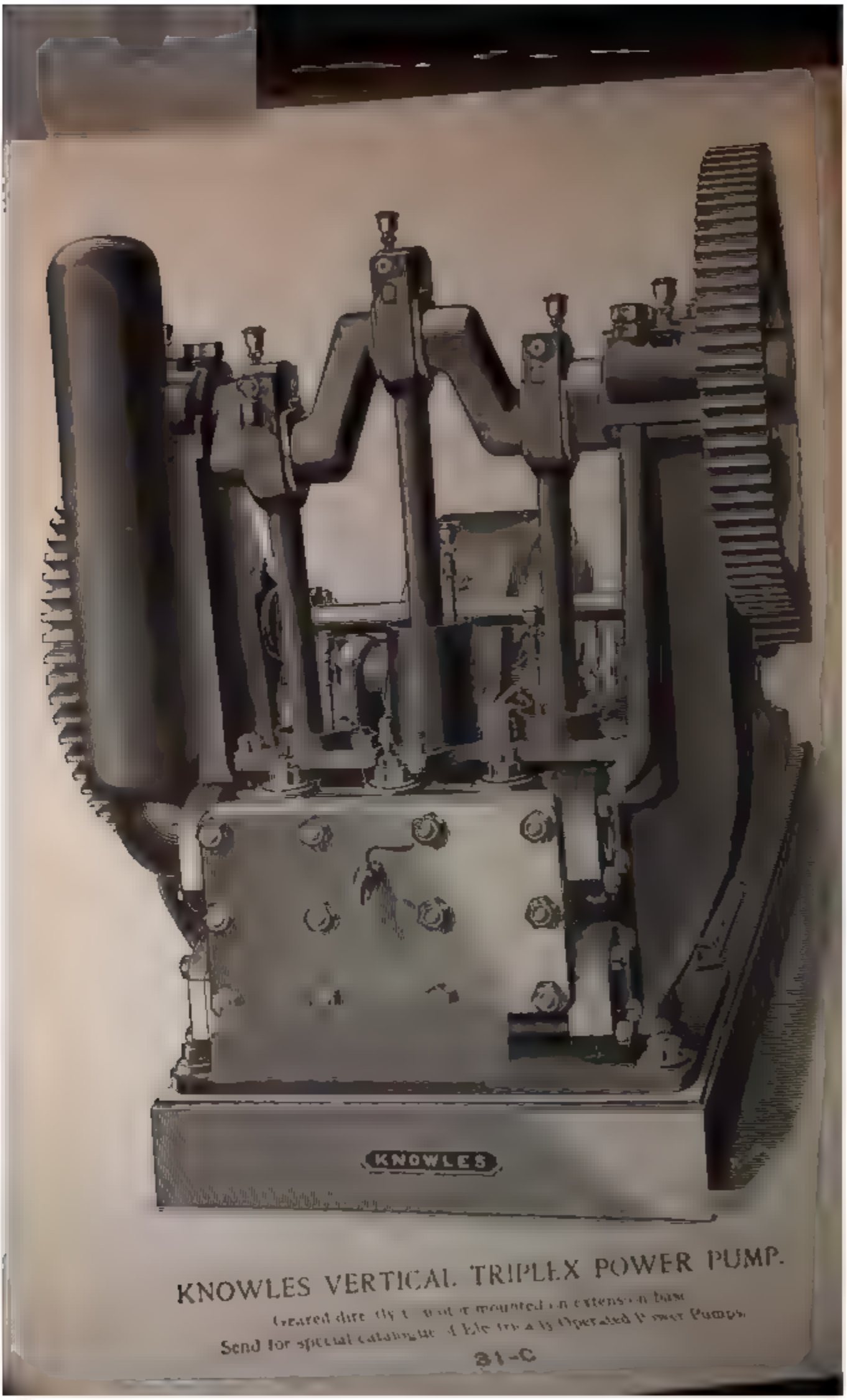
Prices on application. Send full particulars of work pumps will be required to perform—it is much better to have Electric Pumps built expressly for the work they are to do. Send for Special Catalogue of Electrically Operated Power Pumps.



HORIZONTAL TRIPLEX ELECTRIC POWER PUMP.

With Double Acting Outside Packed Plungers.

Prices on application. Send full particulars of work pumps will be required to perform—it is much better to have Electric Pumps built expressly for the work they are to do. Send for Special Catalogue of Electrically Operated Power Pumps



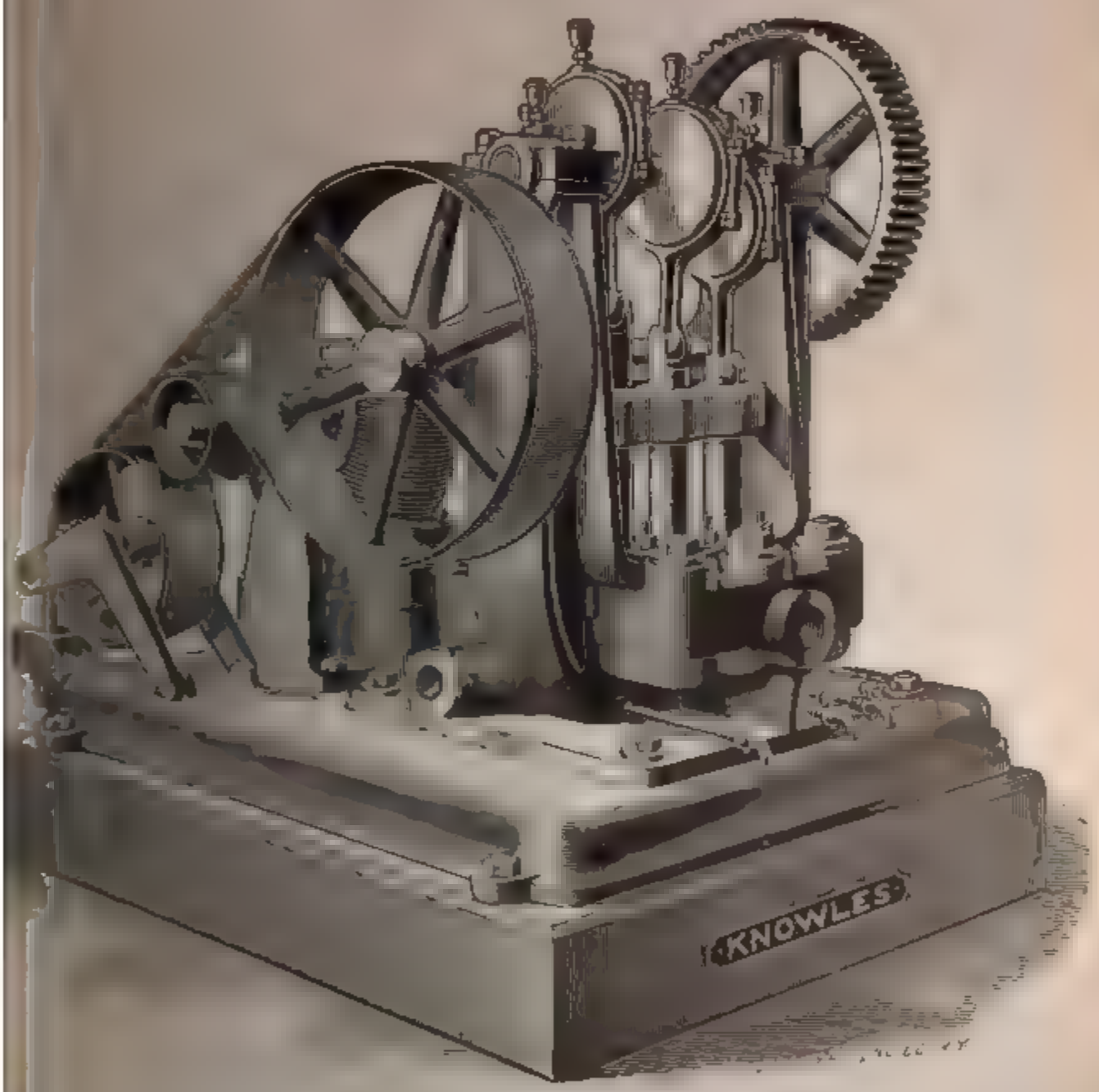
KNOWLES VERTICAL TRIPLEX POWER PUMP.

Geared direct by [illegible] mounted on extension base

Send for special catalogue of Electrically Operated Power Pumps

31-C

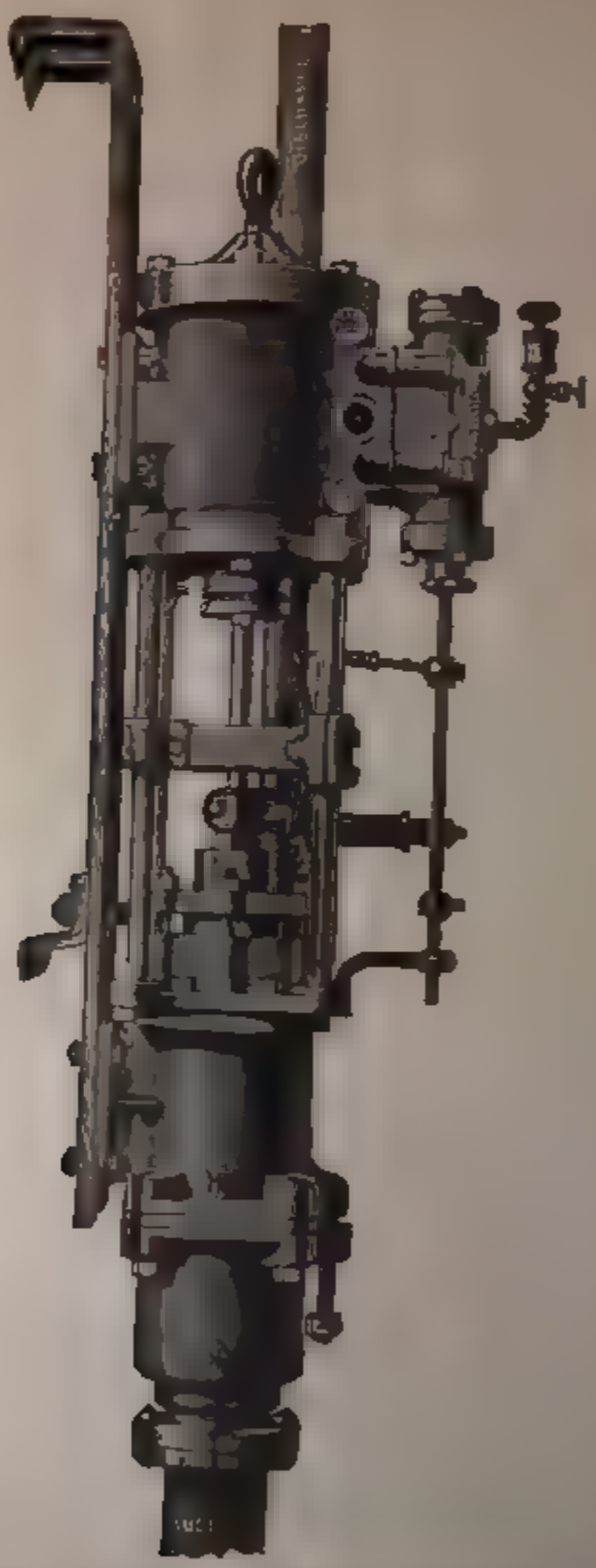
Special Belt Driven Vertical Triplex Electric Power Pump.



This illustration shows one of the smaller sizes of vertical triplex pumps with extension bed plate for electric motor, but connected by a special form of belt transmission instead of gearing as in the ordinary pattern.

While not mechanically so efficient a device as a pair of machine cut gears, this arrangement combines the noiselessness of a belted power pump with extreme compactness, making it a very desirable form for house, hotel and public building service.

Send for special catalogue of Electrically Operated Power Pumps.



KNOWLES PATENT VERTICAL SINKING PUMP.

[redacted]

KNOWLES PATENT

ERTICAL SINKING PUMP.

"BUCKET AND PLUNGER" PATTERN.

proved type of sinking pump is especially adapted for sinking new shafts, ering "drowned-out" mines, and for general excavating work involving a ter level. It is compact, easily handled, and, while designed to work in a ition, will operate satisfactorily at any desired angle, either suspended by a oked to the shaft timbering. It is positive in operation, throws a steady, con- am of water, and owing to the improved form of valve motion, and a special device in the steam cylinder, is exceedingly quiet in action.

ver plunger, or "bucket," works in a *removable* cylinder of hard iron, which laced readily and at slight expense when worn out.

bolts allow of easy access to the pump barrel and valves, the latter being of ized rubber, with gun-metal seats. The suction opening is at the lower end, for attaching hose or piping, the discharge nozzle being above and to one water cylinder. Each pump is fitted with a ring bolt, firmly imbedded in the ad, for hanging by tackle, and with adjustable wrought-iron dogs bolted to r hanging from shaft timbers.

Diameter of Upper Plunger	Stroke	Gallons per Stroke.	Capacity per Minute, Gallons.	Steam Pipe	Exhaust Pipe.	Suction Pipe	Discharge Pipe.	Dimensions over all.	Shipping Weight	Code Word.
3¾	7	.34	30	¾	1	3½	2	65 x 17 x 17	700	Aneugmale
3¾	10	.48	40	¾	1	3½	2	70 x 18 x 13	745	Aneurism
3¾	10	.48	40	1	1¼	3½	2	71 x 18 x 13	935	Anexabasis
4½	10	.69	80	1	1¼	4	2½	72 x 22 x 15	1080	Anexadore
5	10	.85	100	1¼	1½	4	3	72 x 22 x 15	1150	Anexaisa
6	12	1 47	150	2	2½	5	4	80 x 24 x 17	2510	Anexamort
7	16	2.66	200	2	2½	6	5	114 x 29 x 22	2900	Anexarias
7	16	2.66	200	2	2½	6	5	114 x 29 x 22	3040	Anexarse
7	16	2.66	200	2½	3	6	5	115 x 29 x 23	3325	Anexaroni
8½	16	3.92	300	2½	3	8	6	115 x 30 x 23	5005	Anexasten
8½	16	3.92	300	2½	3	8	6	116 x 31 x 24	5150	Anexidades
10	24	8.16	400	3½	4	10	6	152 x 40 x 30	6535	Anexim
10	24	8.16	400	3½	4	10	6	152 x 40 x 30	7430	Anfacheln
10	24	8 16	400	3½	4	10	6	156 x 38 x 45	8000	Anfabros
12	24	11.75	580	2	2½	10	8	152 x 43 x 33	7100	Anfaneva
12	24	11 75	580	3½	4	10	8	152 x 43 x 43	9500	Anfanolas

ties given are for a piston speed of about 100 feet per minute. This may be doubled ency, but we do not recommend exceeding it for continuous service.

Before connecting up sinking pump blow out the steam pipe thoroughly
Any dirt or rubbish carried into the steam cylinder will cut it and injure it
seriously. After pump is connected remove reverse valve covers or plugs, take
out the valves and let steam blow through. Then carefully wipe the valves and
pockets clean before replacing the valves.

SPECIAL VERTICAL PLUNGER SINKING PUMP.

[redacted]

KNOWLES PATENT

VERTICAL SINKING PUMP.

Outside Packed Plunger Pattern.

his type of pump a hard iron plunger moves in two working-barrels having stuffing oxes and glands fitted with swing bolts for convenience in packing. The valves f medium hard rubber, with brass seats, bolts and springs, the valve chamber being endent and easily removable for inspection or repairs. The suction valve chamber ed with automatic air valves for relieving the pump of air, and the discharge air ber has a cock for the same purpose. The discharge elbow is fitted with a lard flange and has a cock for drawing off the water in discharge pipe when desired. bottom flange of the lower working barrel has swing bolts for convenience of val in order to take out sand or gravel, and the discharge air chamber is in one , securing compactness and minimum weight.

The steam cylinder has a recently improved valve gear, without external moving , thus reducing the liability to injury from accident or rough usage. The entire n of this pump is exceptionally strong and compact; workmanship and materials f the best, and fully warranted in every respect.

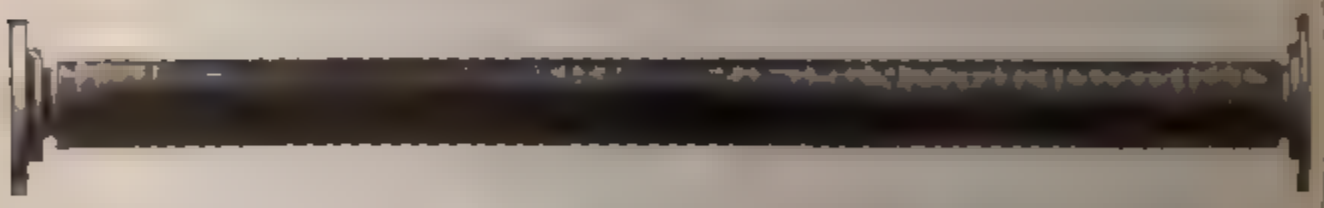
Cylinder. Diameter of Plungers	Stroke	Gallons per Stroke.	*Capacity per Minute Gallons	Steam Pipe	Exhaust Pipe	Suction Pipe	Discharge Pipe	Dimensions over all.	Shipping Weight	Code Word.
3½	12	.50	50	1	1½	2½	2	74 x 25 x 27⅝	1245	Jobation
4	12	.65	65	1	1½	3½	2½	74 x 25 x 27⅝	1375	Jobber
4½	12	.80	80	1	1½	4	3	83¼ x 25 x 31¼	1565	Jockey
3¾	12	.55	55	1½	2	3½	2½	86 x 28⅞ x 27⅝	1585	Jocund
4½	13	.89	85	1½	2	4	3	88 x 28⅞ x 31¼	1905	Joist
5	13	1 10	100	1½	2	4	3	88 x 28⅞ x 31¼	1905	Joker
6	13	1 59	150	1½	2½	5	4	98 x 32½ x 36⅝	2990	Jolly
7	14	2 33	200	1½	2½	5	4	108 x 34⅝ x 39⅝	3680	Jolted
7	14	2 33	200	2	3	5	4	112⅜ x 38⅝ x 39⅝	4150	Jostle
8	16	3 48	260	2½	4	6	5	124 x 44 x 43	5250	Jostrel
9	16	4.41	330	3	4	6	5	126 x 46 x 45	7500	Jotbar
6 12	20	9 79	587	3	5	10	8	175¾ x 40⅝ x 38½	10800	Joyfully
6 12	20	9.79	587	3	5	10	8	176¼ x 46 x 39	14500	Joyfulness

apacities given are for a piston speed of about 100 feet per minute. This may be d in an emergency, but we do not recommend exceeding it for continuous service.
tyle No. 1 (Regular Pattern) ‡Style No. 2 (Pot Valve Pattern.)
e last two sizes in the table have two steam cylinders placed tandem on the same rod, king steam at full pressure. Send for circular of the **PALMER SPECIAL SINKER.**

Special Wrought-Iron Column Pipe.

THIS pipe is made of a superior quality of lap welded wrought iron, with patent cast iron lugged flanges, and furnished complete with bolts, nuts and gaskets. It comes in all sizes, from 6 inches to 15 inches, outside diameter cut to specific length not exceeding 15 feet. The flanges are shrunk or expanded and beaded, they are also faced off and counter bored, with male and female joints. With this arrangement it is impossible for the gaskets to blow out. This pipe is tested to 1000 pounds per square inch, consequently it has the advantage of great strength, yet it is much lighter than any other form of pipe, which makes a great saving in freight and handling. Further particulars and prices furnished on application.

Suction Hose and Connections.



THIS Suction Hose is adapted especially for mining work, and is of a superior quality of vulcanized rubber, made on spirally wound flat galvanized iron. The couplings at each end are plain flanges for bolting to the suction nozzle of pump and to the flanges of the strainer. This hose comes in all sizes, from two to ten inches.

EXPANSION JOINT FOR STEAM PIPE.

PRICES ON APPLICATION.

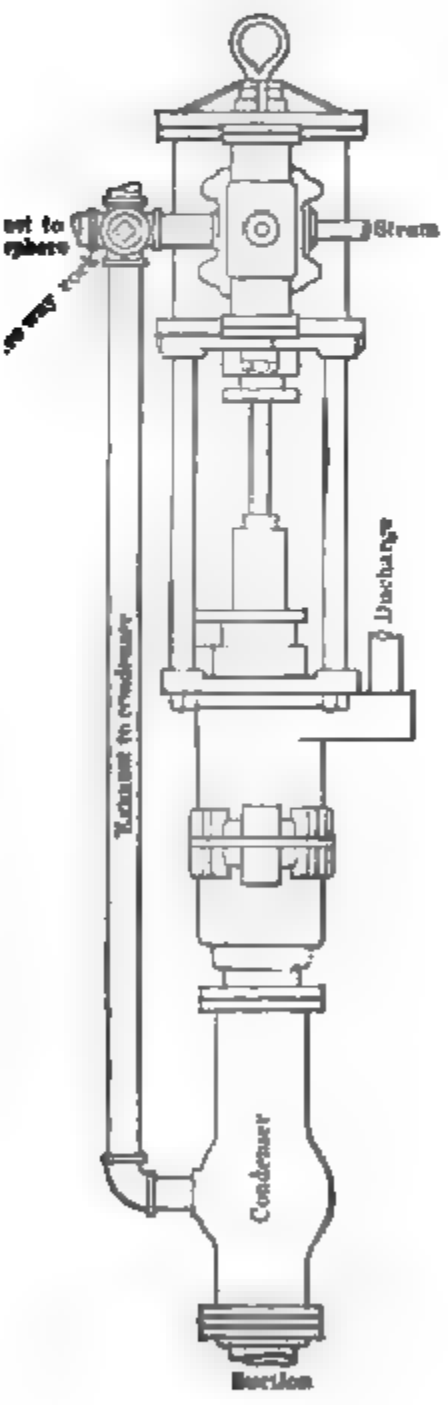
[redacted]

KNOWLES IMPROVED

SUCTION CONDENSER.

For Sinking Pumps.

IE accompanying diagram shows the general arrangement and connections of our Patent Suction Condenser, which may be bolted directly to the suction end of any r Mine Sinking Pumps.

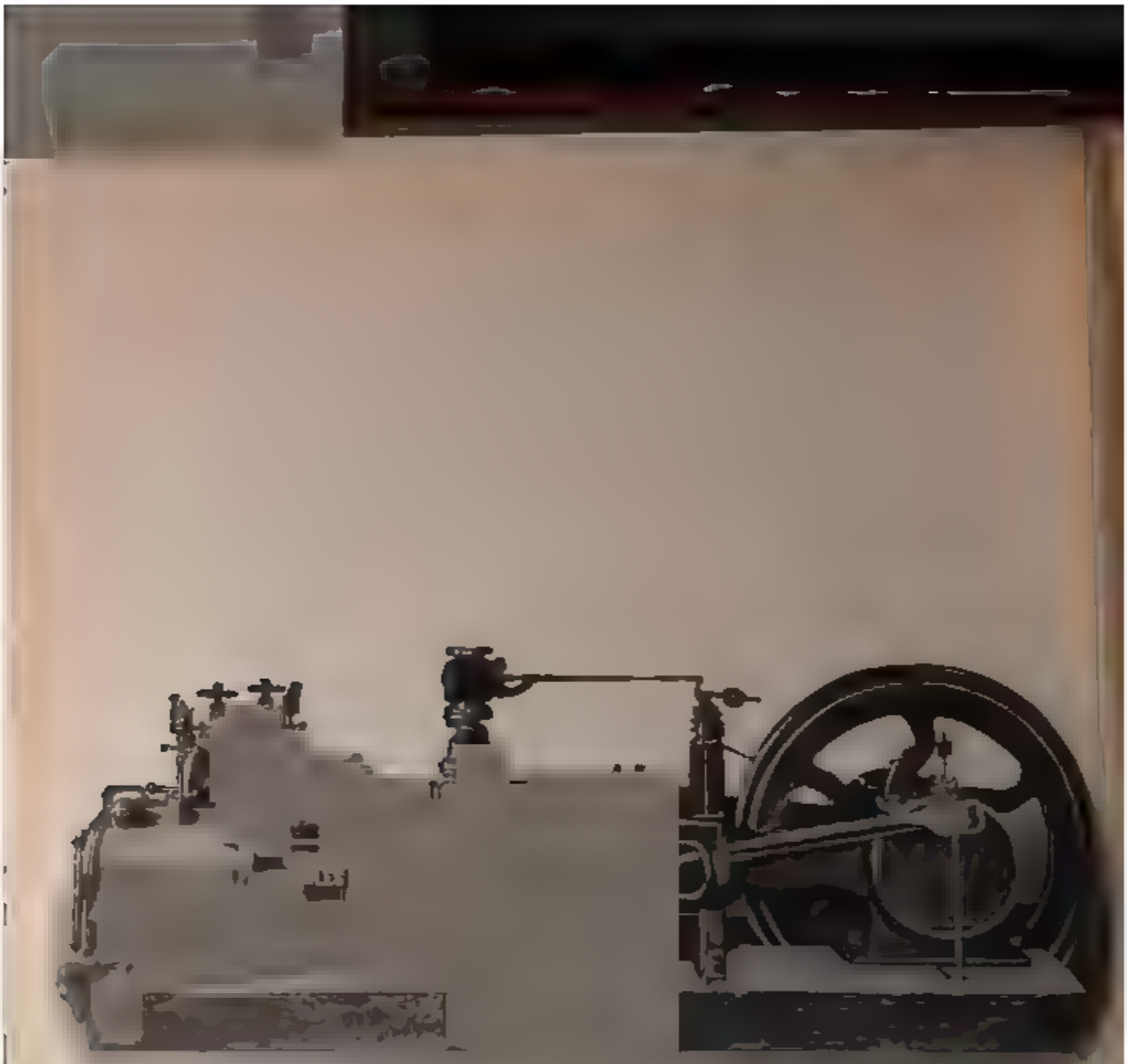


A three-way cock is used with this apparatus, allowing the steam to exhaust into the atmosphere when the pump is first started, and passing it to the condenser when the pump has taken its water and is making full stroke. The construction is extremely compact and efficient, the exhaust being received in an annular space surrounding the suction column, and the water of condensation withdrawn by an ejector action due to its flow.

Sizes given in table are standard for our own pumps, others built to order at short notice.

*SIZE	WEIGHT	PRICE.	CODE WORD.
2½	210		Jabber
3	240		Jackal
3½	300		Jackdaw
4	350		Jaguar
5	450		Jangle
6	600		Jasmine
8	800		Jasper
10	1500		Jaundice

*Corresponding to diameter of suction opening of pump.



KNOWLES IMPROVED DUPLEX CRANK AND FLY-WHEEL AIR COMPRESSOR.

Size, 12x12x18

KNOWLES IMPROVED
DUPLEX AIR COMPRESSORS.

HORIZONTAL CRANK AND FLY-WHEEL PATTERN.

THE cut on the opposite page illustrates one of the Knowles Duplex Crank and Fly Wheel Air Compressors. For large plants these duplex compressors are specially suited, since in obtaining a given quantity of air two air cylinders are employed, also two steam cylinders, thus making a machine less cumbersome in its parts than a single compressor of equivalent capacity. At a slight extra cost, this style of compressor can be piped so that either side may be run independently, thus guarding against a total stoppage of the plant should an accident occur to one side of the machine.

This type of compressor is also made cross-compound, either condensing or non-condensing, the high pressure steam cylinder operating one air cylinder and the low pressure steam cylinder operating the opposite air cylinder. The steam cylinders being arranged with cut-off, it not only makes a simple but an economical form of compressor.

The duplex as well as the single compressors are fitted, when specially ordered, with adjustable governors, so that they may be operated at the proper speed with the varying steam pressures so commonly found in factories, etc. Prices on these governors will be quoted on application. The machine throughout is rigid. The fly-wheel end Corliss type of frame, strongly bolted to the steam cylinders, while the air cylinders are tied to the steam cylinders by cast iron distance pieces. The air cylinders are "water-jacketed," each provided with a sight feed lubricator, the valves of improved pattern, the steam cylinders fitted with sight feed lubricators, and all bearings provided with sight feed oil cups. The workmanship and material throughout are of the best, and the efficiency and satisfactory operation of this type of compressor fully guaranteed. We also make cross-compound compressors, condensing and non-condensing. Send for special catalogue of air compressing machinery.

SIZES AND CAPACITIES.—STYLE D.

Diameter Steam Cylinder.	Diameter Air Cylinder.	Length of Stroke.	Number of Revolutions per Minute.	Cubic Feet Free Air per Minute.	No. of 3-in. Drills or Coal Cutters Compressor will run.	Sizes of Pipes.			Weight of Compressor Complete, Duplex.	Telegraphic Code Word.
						Main Steam.	Exhaust.	Air Discharge.		
8	8	12	160	224	2	2	2	3½	8100	Faubourg
8	10	12	160	350	4	2	2	4	8200	Fauces
10	10	12	160	350	4	2½	3	4	8400	Faulter
10	12	12	160	500	6	2½	3	4½	8500	Faultful
14	14	12	160	684	8	4½	4	5	17000	Faulted
10	10	18	120	393	4	2½	3	4	16000	Faultily
12	12	18	120	564	6	3½	3½	5	17500	Faultless
12	14	18	120	770	10	3½	3½	5	18000	Faulty
12	16	18	120	1004	14	3½	3½	6	21000	Faun
14	14	18	120	770	10	4½	4	6	20000	Fauna
14	16	18	120	1004	14	4½	4	6	22000	Fautor
14	18	18	120	1268	18	4½	4	7	24000	Fautress
16	16	18	120	1004	14	5	6	6	30000	Favored
16	18	18	120	1268	18	5	6	7	35000	Favoring
18	16	18	120	1004	14	5	6	6	36000	Favorite

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

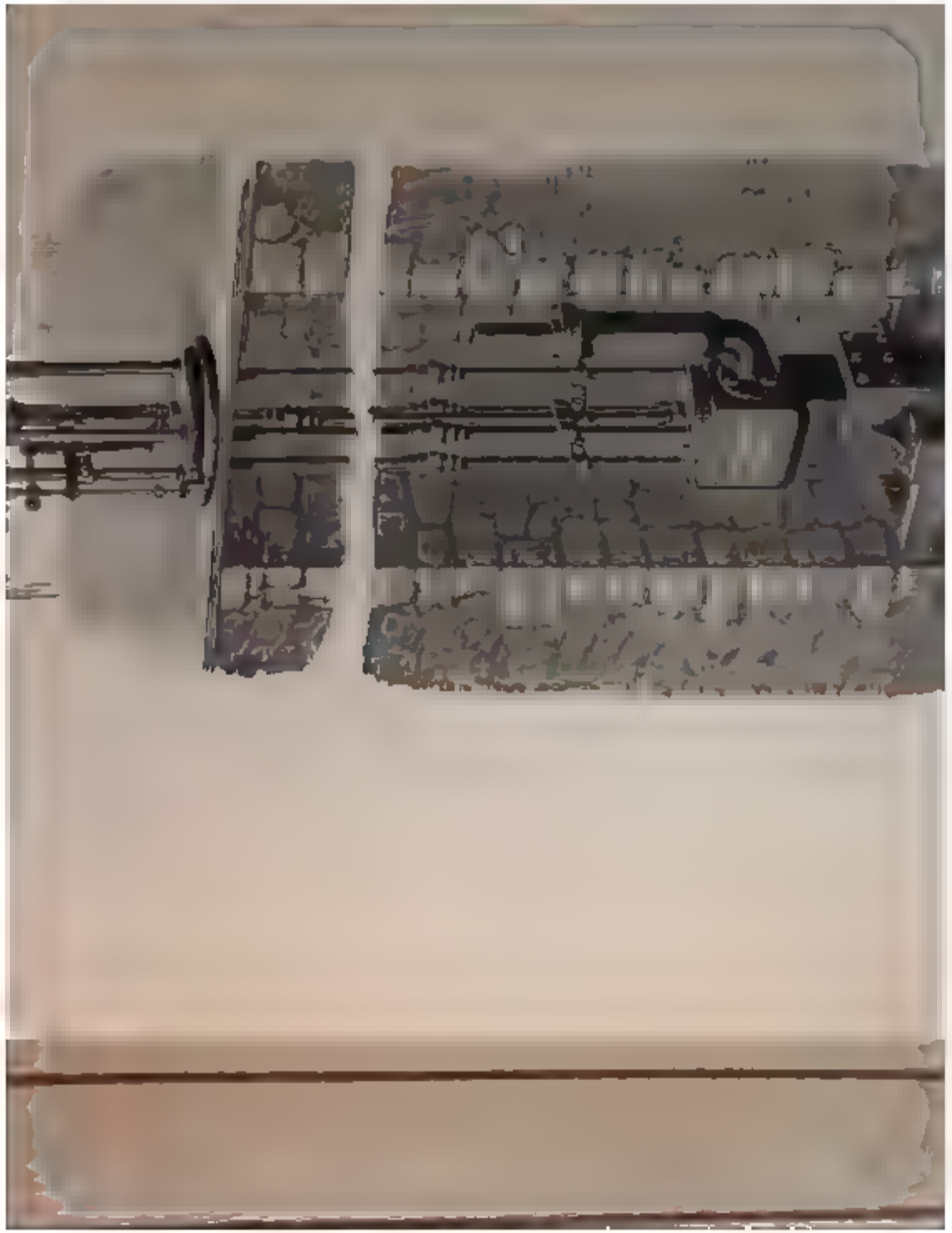
We have built several complete sets of our improved Air Compressing Engines for the largest and most modern designed pneumatic despatch system in the world, aggregating 1600 horse power.

Parties ordering Air Compressors will please state fully the particulars of duty to be performed. If for working rock drills, state size and make of drills. If for running coal cutting machines, pumps, or other like machinery, state size of cylinders, speed, and required air pressure.

POWER AIR COMPRESSORS also made — Duplex or Single pattern. Send for particulars.

SINGLE AIR COMPRESSORS, crank and fly-wheel pattern, see pages 50 and 51.

BREWERS' DUPLEX AIR PUMPS, see pages 42 and 43.



KNOWLES PATENT

DEEP WELL PUMPS.

Vertical Double-Acting Piston Pattern.

FOR deep wells and other contracted places requiring the steam cylinders and pump cylinders to be placed at considerable distance apart, these improved pumps are especially adapted. They are arranged with uble-acting pump cylinders, so that a steady, continuous stream of water is delivered. The steam cylinders ng properly proportioned to the water cylinders, they will elevate water to *any* height or distance desired.

These pumps have all the improvements found in our regular horizontal pumps, with the advantage that y take but little room; there is no inconvenience in having to go down in the wells to start or look after am cylinders, and there is no condensed steam or oil to drop into the water.

The steam cylinder is arranged for bolting to woodwork at the mouth of the well or shaft. The water inder can be located at any depth desired, the tie-rods and pump-rod being made of proper length to suit conditions of each individual case.

The lining, piston rod, stuffing box, valve seats, valve bolts, etc., of the water cylinder are made of the best mposition. The water piston is also made of composition and arranged with adjustable packing.

SIZES, CAPACITIES AND PRICES:

Steam Cylinder. Inches.	Water Cylinder. Inches.	Stroke. Inches.	Gallons per Stroke.	*Capacity per Minute at Ordinary Speed.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipe. Inches.	Delivery Pipe. Inches.	Price.
4	3	5	.15	15 Gallons	½	¾	2	1½	
6	4½	7	.48	48 "	¾	1	2	1½	
6	5	7	.60	60 "	¾	1	3	2½	
6	5½	7	.72	72 "	¾	1	3	2½	
8	5	12	1.02	80 "	1	1¼	3½	3	
8	6	12	1.47	118 "	1	1¼	3½	3	
10	6	12	1.47	118 "	1¼	1½	3½	3	
10	7	12	2.00	160 "	1¼	1½	4	3½	
10	7	18	3.00	160 "	1¼	1½	5	4	
12	7	18	3.00	160 "	2	2½	5	4	
12	8	18	3.92	209 "	2	2½	5	4	
12	9	18	4.96	275 "	2	2½	6	4	
12	10	18	6.12	327 "	2	2½	8	6	
14	8	18	3.92	209 "	2	2½	5	4	
14	9	18	4.96	275 "	2	2½	6	4	
14	10	18	6.12	327 "	2	2½	8	6	
16	10	24	8.16	327 "	2½	3	8	6	
16	12	24	11.75	460 "	2½	3	8	6	
18	14	24	16.00	640 "	3½	4	10	8	

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

*This column gives the capacities at the moderate speed of about 80 feet piston travel per inute. When necessary, this rate of speed can be increased.

Connections to suit any depth of well or shaft, furnished at extra cost.

"ARTESIAN" WELL PUMPS, for bored or driven wells, see next two pages.

KNOWLES "STANDARD" ARTESIAN WELL PUMP.

KNOWLES "SPECIAL" ARTESIAN WELL PUMP.

[redacted]

KNOWLES PATENT

"ARTESIAN" WELL PUMPS.

Vertical Bucket-Plunger Pattern.

THIS improved form of the Knowles Vertical Steam Pump is especially designed for *non*-flowing "Artesian" or bored wells, and for driven pipe wells where the water fails to rise within drafting distance (say 25 feet) of the surface. These pumps are much simpler, less expensive, and not so liable to get out of order as the more complicated and cumbersome "working-beam" or rotative pumps. They will pump from the deepest wells (2000 feet if desired) and deliver a steady stream of water (or oil) to any point.

On the opposite page are given two views, *i.e.*, the steam end, as it appears in position at the mouth of well, and the "working barrel," or pump end, located at the bottom. This latter is a casting of the hardest composition (not soft brass tubing), and is carefully bored out and fitted with pump bucket and foot valve. It is screwed on the lower end of the well piping through which the pump rod works. The pump rod connection between the pump bucket and the upper plunger is made of wood or extra heavy iron pipe. The action of the pump is fully controlled by a perfected arrangement of steam valves, making the up and down strokes equally uniform and regular. The pump bucket discharges water on the up stroke and the upper plunger discharges on the down stroke, consequently the flow of water is steady and continuous. The pump bucket and foot valve are of special construction, and can be readily drawn up through the well piping for examination or repairs.

SIZES AND PRICES:

Steam Cylinder. Inches.	Bucket. Inches.	Plunger. Inches.	Stroke. Inches.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Price.	Capacity at 100 Feet Piston Travel.
4	2¾ to 3¼	1⅞ to 2⅜	7	½	¾		30 to 42 galls. per min.
6	2¾ to 4¼	1⅞ to 3	12	¾	1		30 to 72 " "
8	3¼ to 5¾	2⅜ to 4	24	1	1¼		42 to 112 " "
10	3¼ to 8½	2⅜ to 6	24	1¼	2		42 to 288 " "
12	3¼ to 8½	2⅜ to 6	24	1½	2½		42 to 288 " "
14	3¾ to 8½	2⅝ to 6	24	2	3		56 to 288 " "
16	3¾ to 8½	2⅝ to 6	24	2	3		56 to 288 " "

ALSO PATTERNS FOR LARGER SIZES AND OTHER COMBINATIONS.

The steam end is arranged to slide to one side upon the bed plate, which feature is very convenient when it is necessary to pull out the pump rods or take up the well piping.

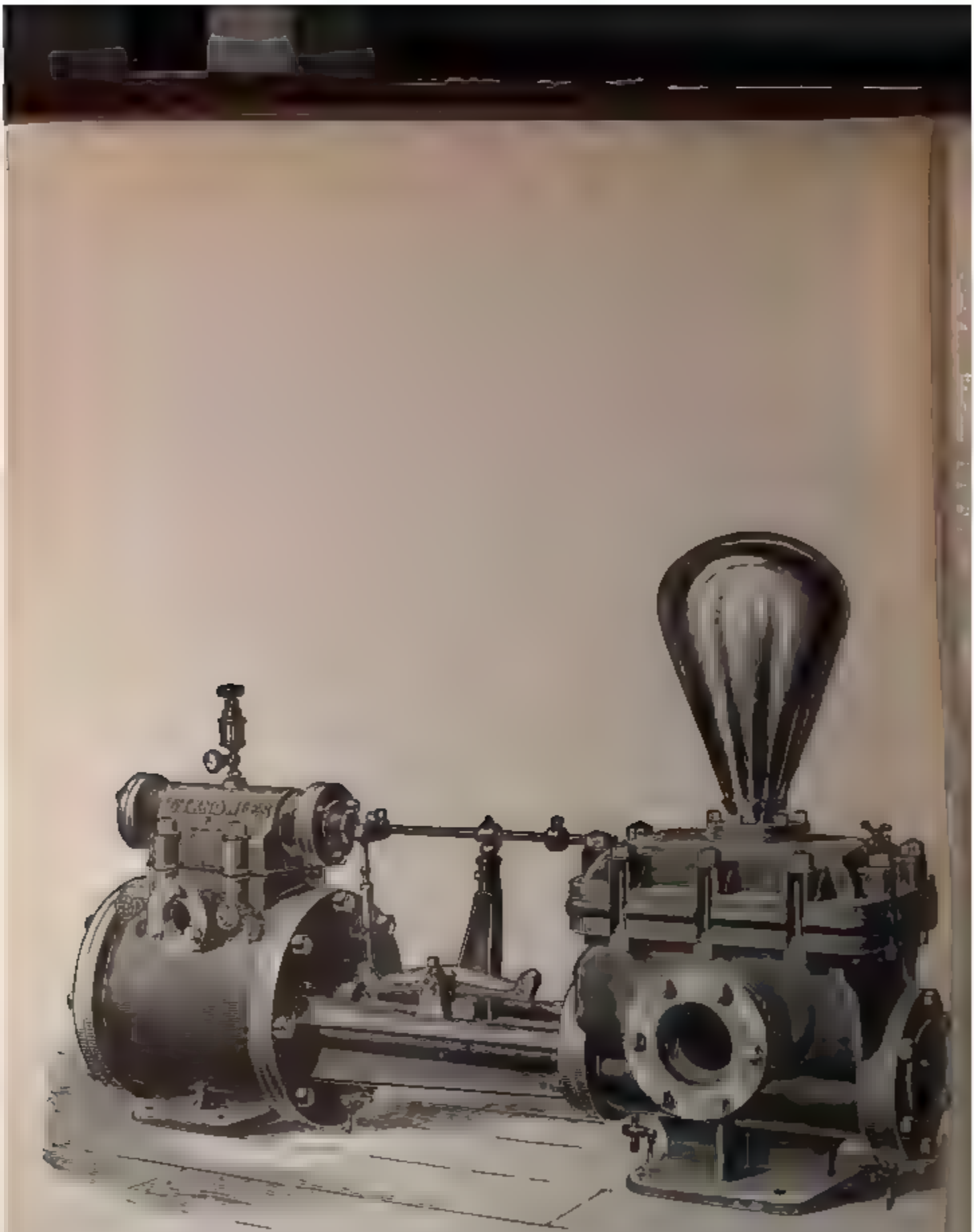
MEMORANDUM.

5	inch	Well	will take	3	inch	Pipe	and	2¼	inch	Bucket, or	3½	inch	Flush	joint	Pipe,	and	3¼	inch	Bucket.
5½	"	"	"	3½	"	"	"	3¼	"	"	4	"	"	"	"	"	3¾	"	"
6	"	"	"	4	"	"	"	3¾	"	"	4½	"	"	"	"	"	4¼	"	"
6½	"	"	"	4½	"	"	"	4¼	"	"	5	"	"	"	"	"	4¾	"	"
7½	"	"	"	5	"	"	"	4¾	"	"	6	"	"	"	"	"	5¾	"	"
8	"	"	"	6	"	"	"	5¾	"	"	7	"	"	"	"	"	6¾	"	"
9	"	"	"	7	"	"	"	6¾	"	"	—	"	"	"	"	"	—	"	"
10	"	"	"	8	"	"	"	7⅝	"	"	—	"	"	"	"	"	—	"	"
12	"	"	"	9	"	"	"	8½	"	"	10	"	"	"	"	"	9½	"	"

Regular Piping is more durable than "Flush Joint" piping; the latter, however, being of less diameter outside admits of the use of larger pump buckets and consequently increased pumping capacity

"Flush Joint" pipe is regular standard wrought iron pipe, without the usual couplings, it has one end of each length boredand tapped—the other end is turned off and threaded. Where it is possible always use regular standard pipe in preference to "Flush joint" pipe or well casing.

***It is well to bear in mind that the pumping capacity of a non-flowing "Artesian" well depends upon the size of its bore. The diameter *of the well limits the size of the piping (at the end of which the pump barrel is screwed) and the diameter of this piping limits the size of the pump bucket.* Hence only a certain amount *of water can be got out of a well of designated bore.*



KNOWLES PATENT BREWERY OR TANNERY PUMP.

For Hot Mash, Beer, Etc.

KNOWLES PATENT

BREWERY OR TANNERY PUMPS.

For Hot or Cold Beer, Mash, etc.

In this class of pumping machinery we have introduced many original designs with a view of increasing their efficiency and durability for service in breweries.

We have patterns for every size and style of pump required, and our improved pump valves, for handling hot or cold beer mash, are warranted not to clog or foul.

The pump pistons, piston-rods, stuffing-boxes, linings, valve seats and bolts, are made of the best composition. All parts being *interchangeable*, can be easily removed and duplicated in case of accidental breakage or unusual wear. The improved water piston is adjustable to any pressure, and always tight.

The water passages are more direct and the valve areas larger in the Knowles pumps than in any other steam pumps in use.

SIZES, CAPACITIES AND PRICES:

Steam Cylinder. Inches.	Pump Cylinder. Inches.	Stroke. Inches.	Gallons per Stroke.	Capacity per Minute at Ordinary Speed.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipe. Inches.	Delivery Pipe. Inches.	Floor Space Required. Inches.	Price.
5	4	7	.39	125 Strokes, 49 gals.	¾	1	2½	2	44 x 12	
6	5¼	7	.72	125 " 90 "	¾	1	3	2½	44 x 13½	
7½	7¼	10	1.91	100 " 191 "	1	1¼	5	5	56½ x 19	
8	6	12	1.47	100 " 147 "	1	1¼	4	4	67 x 19	
8	7	12	2.00	100 " 200 "	1	1¼	5	5	67 x 19	
[illegible]	8	12	2.61	100 " 261 "	1	1¼	5	5	67 x 20	
[illegible]	7	12	2.00	100 " 200 "	1¼	1½	5	5	67 x 19	
[illegible]	8	12	2.61	100 " 261 "	1¼	1½	5	5	67 x 20	
[illegible]	10	12	4.08	100 " 408 "	1¼	1½	6	6	67 x 21½	
[illegible]	8	12	2.61	100 " 261 "	2	2½	5	5	67 x 20	
[illegible]	10	12	4.08	100 " 408 "	2	2½	6	6	67 x 21½	
[illegible]	12	12	5.87	100 " 587 "	2	2½	8	6	67 x 24	
[illegible]	12	16	7.83	75 " 590 "	2	2½	8	6	79 x 24	
[illegible]	10	12	4.08	100 " 408 "	2	2½	6	6	67 x 24	
[illegible]	12	12	5.87	100 " 587 "	2	2½	8	6	67 x 24	
[illegible]	12	16	7.83	75 " 590 "	2	2½	8	6	79 x 24	

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

Each pump has suction and delivery openings on both sides, this makes it very convenient, as connections can be made on either side of pump desired.

EVERY PUMP FULLY WARRANTED.

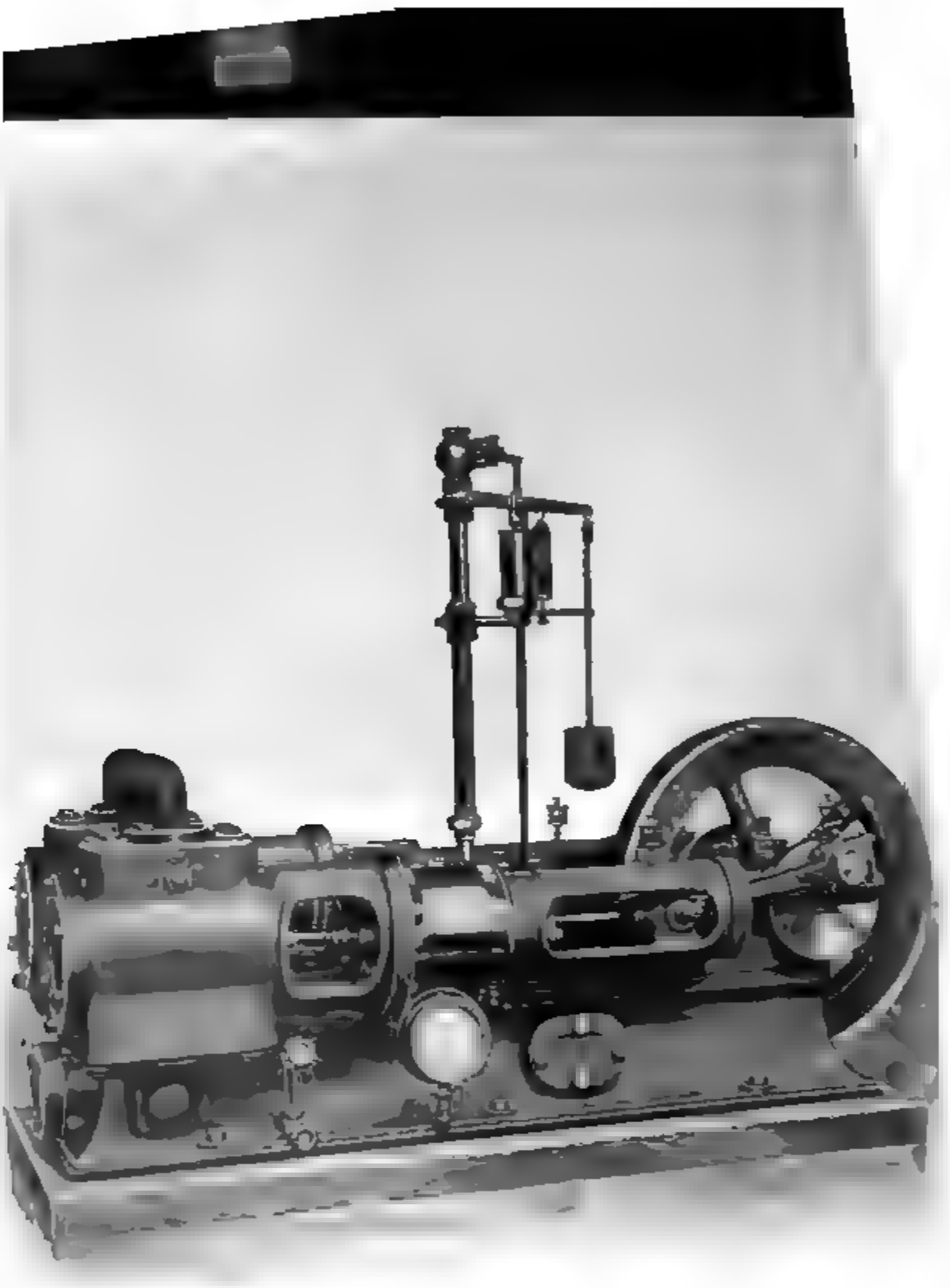
PUMPS for elevating water, etc., to tanks, coolers, etc., see list of "Tank or Light Service Pumps," page 9.

PUMPS for feeding boilers, or forcing water, etc., against heavy pressure, see page 5.

PUMPS for DEEP WELL service, see pages 36 and 37.

"ARTESIAN" WELL PUMPS, see pages 38 and 39.

[illegible]' AIR PUMPS—improved crank and fly-wheel duplex pattern—see next two pages.



KNOWLES PATENT DUPLEX BREWERS' AIR PUMP.

CRANK AND FLY-WHEEL PATTERN.

KNOWLES PATENT DUPLEX CRANK AND FLY WHEEL

BREWERS' AIR PUMPS,

For "Racking Off" Beer, etc.

THE use of air pumps has become so extensive in breweries for "racking off" and moving beer from place to place, that improvements have naturally suggested themselves and been adopted by us. The machine here represented is our latest improvement, and fills the want for an efficient and economical Brewers' Air Pump.

It is built on the crank and fly wheel duplex design, with automatic regulating device. The cranks are set at right-angles, so that there is absolutely no "*dead center*." The operation is therefore perfectly *positive*, enabling the pump to stop and start at any point of stroke.

The speed of the pump is regulated automatically by the *pressure* of air in the receiver, decreasing the motion as the pressure increases, stopping or slowing down the pump when the required amount of pressure is attained, re-starting it and accelerating the motion in proportion to the withdrawal of the air from the receiver.

The governor valve on the steam pipe is connected with and moved by the *regulator*, which latter is operated by the air pressure. "Racking off" can be carried on at several points at the same time without varying the air pressure perceptibly. The pump does not require any attention from the engineer, as it regulates its own speed, starting and stopping automatically as the air is used or shut off. Variation of the steam pressure does not affect the running of the pump, as the regulator controls the speed and keeps the air at a uniform pressure.

SIZES AND CAPACITIES AS FOLLOWS:

Diameter of Steam Cylinder.	Diameter of Air Cylinder.	Stroke.	Revolutions Per Minute	Piston Speed in Feet Per Minute.	Cubic Feet of Free Air Per Minute.	Working Pressure.	Horse Power of Boiler	Steam Pipes. For Brewery Pumps.	Steam Pipes. For Regular Compressors.	Steam Pipes. Exhaust.	Dimensions. Suction	Dimensions. Discharge.	Dimensions. Jacket	Dimensions. Length	Dimensions. Width.	Dimensions. Height	Diameter of Fly Wheel	Weight of Fly Wheel	Telegraphic Code Word
5	6	6	150	150	58	60	9	1	1¼	1½	3	2	⅝	70"	28"	28"	36"	250	Flowered
5	8	6	150	150	104	40		1	1¼	1½	3	2½	⅝	72"	30½"	29"	36"	250	Flowery
6	8	6	150	150	204	60	26	1	1¼	2	3	2½	⅝	75"	33"	30"	28"	325	Fluate
6	10	6	150	150	162	40		1	1¼	2	4	2½	½	81"	39"	33"	28"	325	Fluter

The small amount of water used in the air cylinders to cool the air, seal the valves, and fill the cylinder heads, will accumulate in the bottom of the Air Receiver. The Glass Water Gauge is intended to show the height of this water and indicate when it is necessary to draw it off through the drain cock at bottom.

Every pump is carefully tested under pressure at the factory before shipment, and is therefore

FULLY WARRANTED.

THE KNOWLES IMPROVED SINGLE AMMONIA PUMP.

[redacted]

THE KNOWLES IMPROVED

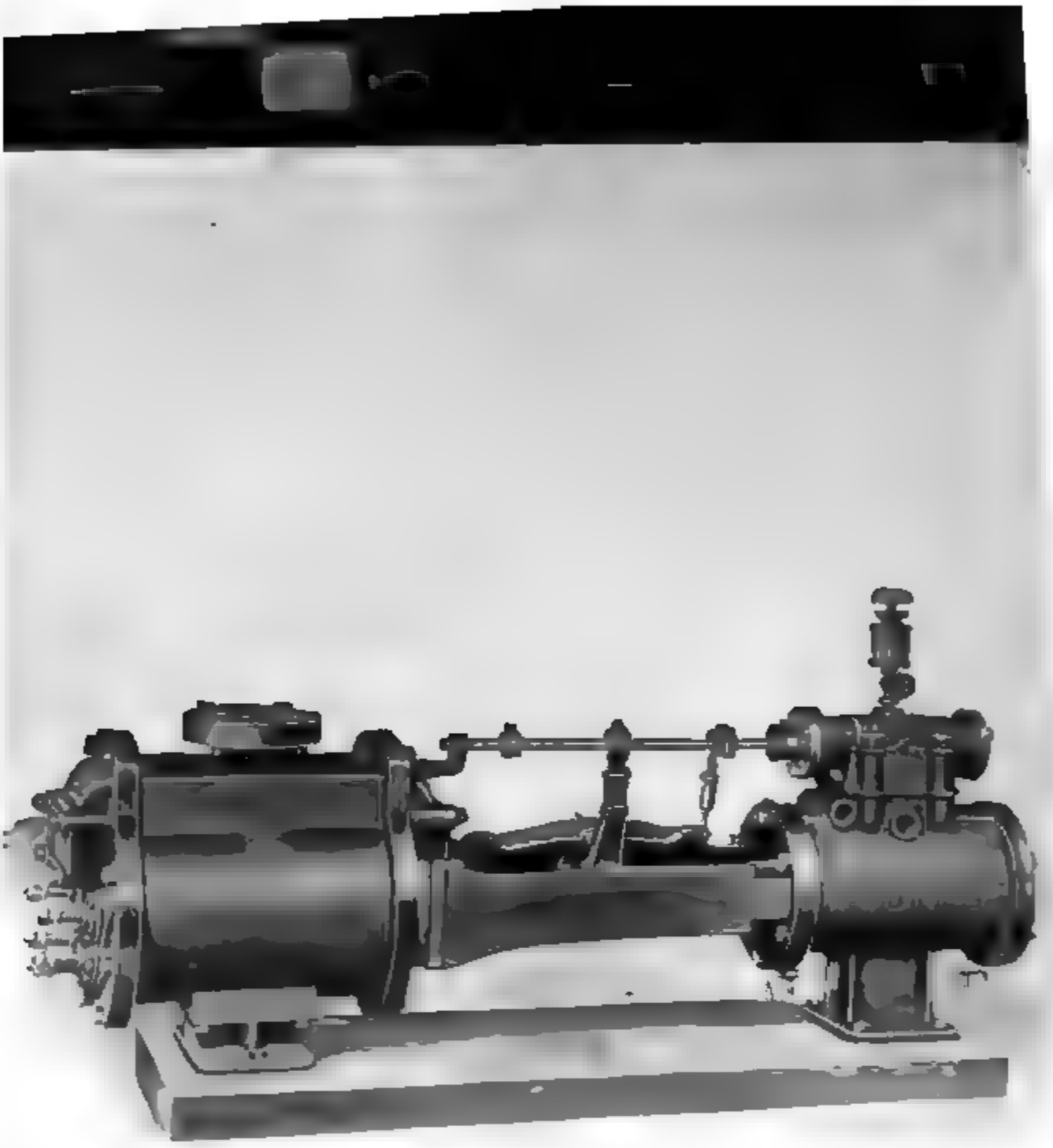
SINGLE AMMONIA PUMP

For 250 Pounds Maximum Pressure,

Made with pump end entirely of iron. Special water-sealed stuffing box on ammonia end.

Steam Cylinder. Inches.	Ammonia Cylinder Inches.	Stroke Inches.	Gallons per Stroke	Steam Pipe. Inches.	Exhaust Pipe Inches.	Suction Pipe Inches	Disc'hge Pipe. Inches.	Telegraphic Code Word.
4	1½	5	.038	½	¾	¾	½	**Malrotada**
4	2	5	.068	½	¾	¾	¾	**Malrotados**
5½	2	7	.095	¾	1	1	¾	**Malrotando**
6	2	7	.095	¾	1	1	¾	**Malrotases**
6	2½	7	.149	¾	1	1	1	**Malroteis**
7	2½	7	.149	1	1¼	1	1	**Malrove**
8	2½	7	.149	1	1¼	1	1	**Malsania**
8	3	7	.214	1	1¼	1¼	1	**Malsanos**
8	2½	10	.213	1	1¼	1¼	1	**Malsch**
8	3	10	.306	1	1¼	1¼	1	**Malscher**
8	3½	10	.416	1	1¼	1¼	1	**Malschheid**
10	3½	10	416	1¼	1½	1¼	1	**Malschjes**
10	3¾	10	.478	1¼	1½	2	1½	**Malschloss**
10	4	10	.544	1¼	1½	2½	2	**Malseance**
12	4	12	.653	2	2½	2½	2	**Malsemaine**
12	5	12	1 020	2	2½	3	2½	**Malsizudo**

Also patterns for larger sizes.



DIRECT ACTING AIR COMPRESSOR

With Open Suction.

Size, 8 x 12 x 12.

[redacted]

Direct Acting Air Compressors.

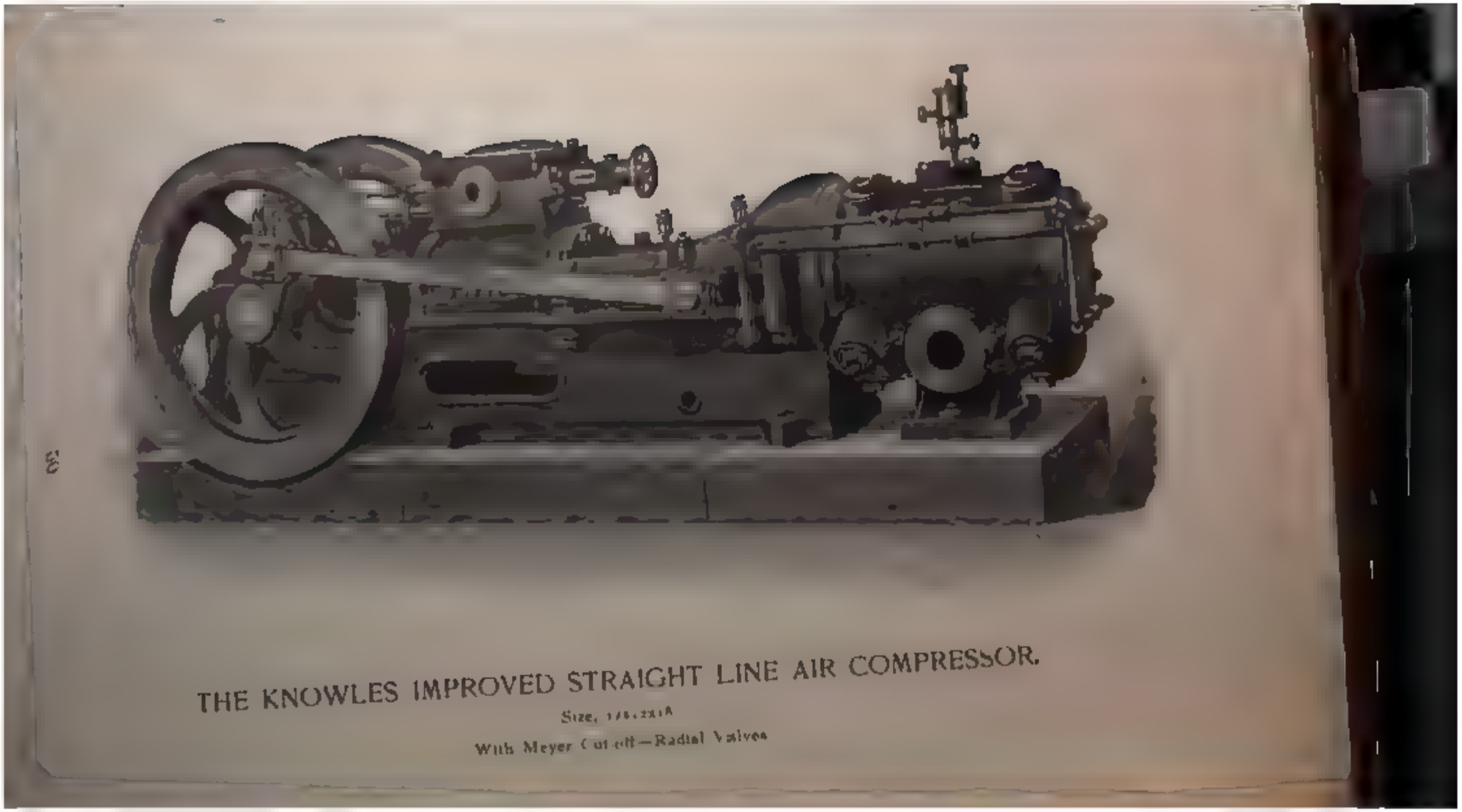
For 5 to 15 Pounds Pressure.

THESE machines are largely used for agitating oils, acids and chemical preparations; also for blast and ventilating purposes, and for supplying air for pneumatic delivery systems and cash carriers. Being direct acting, they are very compact and simple, with the fewest number of working parts possible, and the cost of attendance and maintenance is comparatively nothing. They are universally used in the oil refineries of this country and Russia, and are extensively employed in smelting works, blast furnaces, etc.

Our improved compensating valve motion is of special value on these blowing engines, as the length of stroke can be readily and finely adjusted, so that the pistons can be made to travel close to the heads of the air cylinders, thus combining economy of steam with the most efficient operation at the air end. The air valves are not liable to derangement, and are of very durable form. The pistons are light and strong, and are provided with adjustable packing rings of improved design.

Diameter of Steam Cylinder.	Diameter of Air Cylinder.	Stroke.	Revolutions or Double Strokes Per Minute	Cubic Feet of Free Air Per Minute.	Cubic Feet of Free Air Per Revolution.	Horse Power of Boiler Required.	Pipes. Steam.	Exhaust.	Suction.	Discharge	Dimensions. Length	Width	Height	Telegraphic Code Word. Open Suction.	Confined Suction.
4	4 1/16	5	100	9	.09	1½	⅜	¼	1½	1½	2′	10″	8″	13″	Helpmate.	Hepatite.
4¾	6	6	100	19	.19	2½	½	½	3	2	3′	5″	11″	15″	Helve.	Hepatize.
5½	8	7	100	40	.40	5⅛	¾	1	4	3	3′	10″	13″	19″	Helvetic	Heppen
5½	10	7	100	62	.62	8½	¾	1	4	3	4′	1″	15″	19″	Helvin	Heptade
6	8	12	75	51	.68	7	¾	1	4	3	6′	0″	13″	19″	Hemachate	Heptarch.
6	10	12	75	80	1.06	10⅛	¾	1	4	3	6′	0″	15″	17″	Hematin	Herald
6	15	6	75	90	20	12	¾	1	2½	2½	3′	3″	15″	26″	Hematite.	Heralded.
8	12	12	75	115	1.53	16	1	1¼	6	4	6′	1″	17″	22″	Hemina.	Heraldry.
8	14	12	75	156	2.08	21	1	1¼	6	4	6′	2″	19″	26″	Hemipter	Herbal
10	16	16	50	180	3.60	25	1¼	1⅜	6	5	7′	0″	20″	25″	Hemitone	Herbary
10	16	18	50	205	4.10	28	1¼	1½	6	5	7′	4″	20″	25″	Hemmel.	Herbelet.
10	18	16	50	230	4.60	31	1¼	1½	6	6	7′	0″	21″	29″	Hempy	Herber
10	18	18	50	260	5.20	35	1⅜	1½	6	6	7′	5″	23″	28″	Herdess	Hewed
10	20	16	50	285	5.70	40	1⅜	1½	6	6	6′	6″	27″	28″	Herding	Hewing
10	20	18	50	320	6.40	44	1½	1⅜	6	6	7′	6″	25″	24″	Heremet	Hexade.
10	20	24	40	345	5.62	46	1¼	1½	6	6	9′	3″	25″	29″	Heretog	Hexagon.
12	24	24	40	490	12.25	65	2	2½	10	10	9′	7″	34″	43″	Heriot	Hexapla.
12	30	24	40	770	19.25	100	2	2½	10	10	9′	6″	34″	40″	Herisson	Hexadod.
14	24	24	40	490	12.25	65	2½	3	10	10	9′	3″	29″	37″	Heritor	Heyday.
14	30	16	50	640	12.80	85	2½	3	10	8	7′	0″	36″	42″	Hernhill	Hilled.
14	30	24	40	770	19.25	100	2½	3	10	10	9′	7″	34″	44″	Hernia	Hilliness.
14	30	36	25	720	28.8	95	2½	3	10	10	13′	0″	34″	40″	Hernshaw	Hilly
16	30	36	25	720	28.8	95	2½	3	10	10	13′	3″	34″	40″	Heroical	Hilted.
18	30	36	25	720	28.8	95	3⅛	4	10	10	13′	4″	34″	40″	Heroine	Hilum.
16	36	36	25	1040	41.6	135	3½	4	12	12	13′	0″	42″	51″	Heron	Hinder.
20	36	36	25	1040	41.6	135	3½	4	12	12	13′	0″	42″	56″	Heronry	Hinderance.
20	42	48	20	1400	56	1⅝	3½	4	14	14	17′	0″	49″	63″	Heroship	Hindered.
24	48	48	20	2000	100	260	4	5	14	14	7′	6″	56″	66″	Herpes	Hinging.

Compressors fitted with "Open" suction take their air supply directly from the atmosphere surrounding the air cylinders. Compressors with "Confined" suction have the suction valves enclosed in a confined space, with an opening to which a pipe may be attached, so as to draw the supply for the compressor from any desired source.



THE KNOWLES IMPROVED STRAIGHT LINE AIR COMPRESSOR.

Size, 17½ x 21 A

With Meyer Cut-off—Radial Valves

[redacted]

THE KNOWLES
SINGLE CYLINDER CRANK AND FLY-WHEEL
AIR COMPRESSOR.

For Elevating Acids by Air Pressure, for Operating Pneumatic Machinery, etc.

THESE "Straight-Line" Air Compressors are made, in the smaller sizes, with the air valves located in the air cylinder heads. The larger sizes may be provided with radial valves located around the air cylinder barrel, as shown in the cut on the opposite page. It will be seen at a glance that this type of compressor is very compact and thoroughly self-contained, and, when properly set, its perfect alignment in continuous service can be relied upon.

Steam and air cylinders are both provided with sight feed lubricators, and all the bearings are fitted with sight feed oil cups. The air cylinder is "water jacketed," and so arranged that the cooling water enters at the compression ends of the cylinders, and after the heat due to compression is absorbed, the water is discharged at the centre.

In large plants where the saving in steam consumption is sufficient to warrant the extra cost, these compressors are fitted with Corliss valve gear and may be run condensing or non-condensing.

Where the air or gas is required to be compressed to pressures greater than about one hundred pounds per square inch, we recommend the use of a compressor with *compound air end*, having two or more air cylinders of different sizes. The initial compression takes place in the larger cylinder. After this first compression, the air or gas passes on to the next cylinder, where the pressure is still further increased, and, if there is a third air cylinder, the process is again continued until the required pressure is reached.

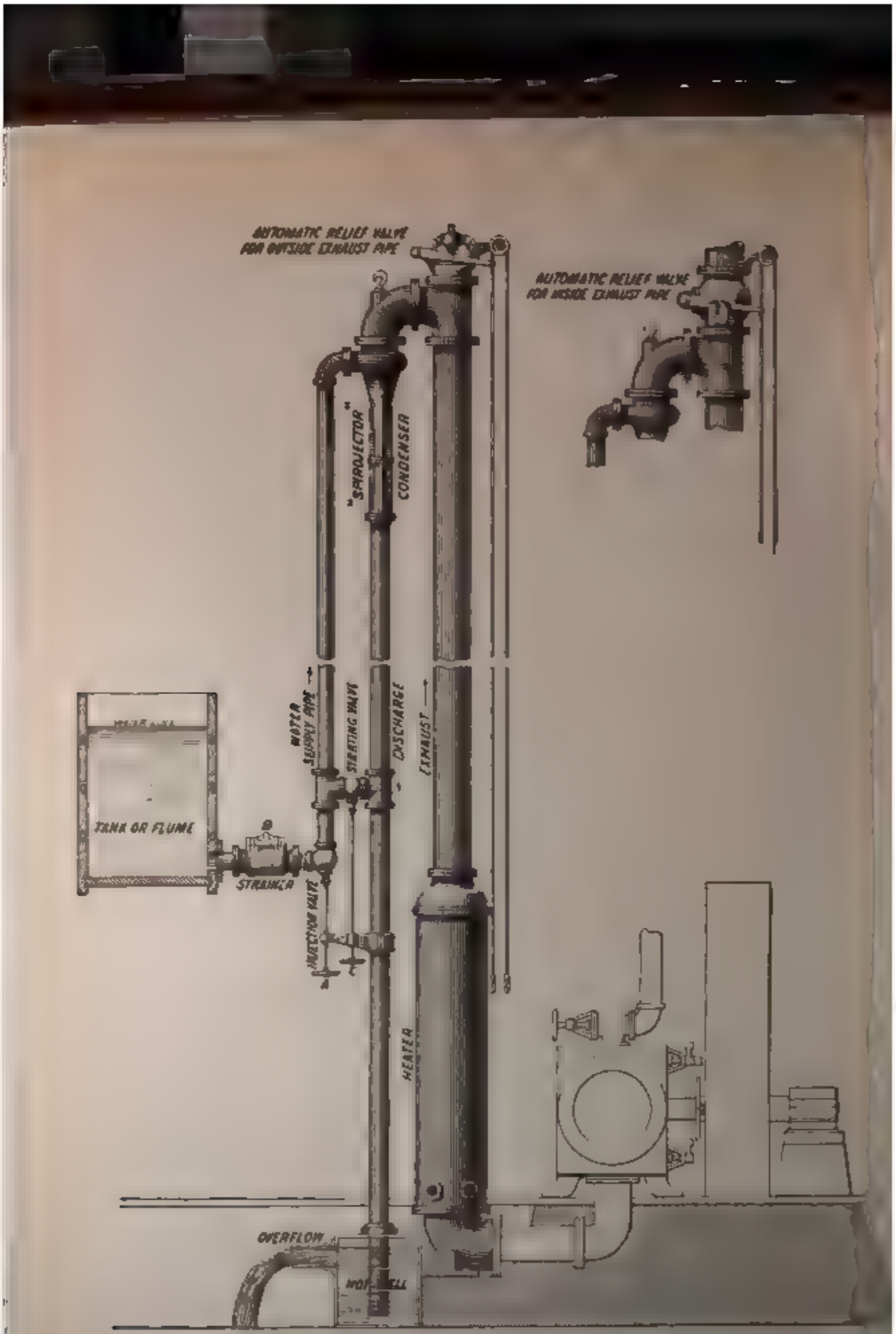
SIZES AND CAPACITIES.— .—STYLES A AND B.

Diameter of Steam Cylinder.	Diameter of Air Cylinder.	Length of Stroke.	Number of Revolutions per Minute.	Cubic Feet of Free Air per Minute.	No. of 3 in. Drills or Coal Cutters Compressor will run	Size of Steam Pipe.	Size of Exhaust Pipe.	Size of Air Pipe.	Weight of Compressor Complete.	Telegraphic Code Word.
6	5	7	180	29		1	1½	1½	1000	Farrier
6	6	7	180	42		1	1½	1½	1100	Farrow
6	7	7	180	56		1	1½	1½	1700	Farthest
8	7	7	180	56		1¼	2	2	1800	Farthing
8	8	7	180	73		1¼	2	2	1900	Fascicle
8	8	12	160	112	1	1½	2½	2½	2900	Fascinate
8	10	12	160	175	2	1½	2½	3	3900	Fashion
10	10	12	160	175	2	2	3	3	4100	Fastener
10	12	12	160	250	3	2	3	3½	4900	Fastening
10	12	16	140	292	3	2	3	3½	6100	Faster
12	10	12	160	175	2	2½	3½	3	5000	Fastidious
12	12	12	160	250	3	2½	3½	3½	5200	Fasting
12	12	16	140	292	3	2½	3½	3½	6300	Fatal
12	14	16	140	399	5	2½	3½	4	8100	Fatalist
14	12	16	140	292	3	3½	4	3½	8200	Fatality
14	14	16	140	399	5	3½	4	4	9500	Fatally
WITH RADIAL VALVES.—STYLE C.										
12	12	18	120	282	3	2½	3½	3½	8000	Fated
*12	12	18	120	282	3	2½	3½	3½	9700	Fateful
12	14	18	120	385	5	2½	3½	4	10800	Father
*12	14	18	120	385	5	2½	3½	4	11800	Fatherly
14	14	18	120	385	5	3	4	4	11500	Fathom
*14	14	18	120	385	5	3	4	4	12000	Fatigue
*14	16	18	120	502	7	3	4	4½	12500	Fatling
*16	16	18	120	502	7	3½	4	4½	14000	Fatly
*16	18	18	120	634	9	3½	4	5	16000	Fatness
*18	18	18	120	634	9	4½	5	5	18000	Fatras
*16	18	24	95	670	10	4	5	5	20000	Fatted
*18	18	24	95	670	10	4½	5	5	23000	Fatten
*18	20	24	95	828	12	5	5	6	24000	Fattish
*20	20	24	95	828	12	5	6	6	25000	Fatty
*24	24	30	75	1177	16	6	7	6	34600	Fatuity

* Table gives weight when fitted with Meyer cut-off.

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

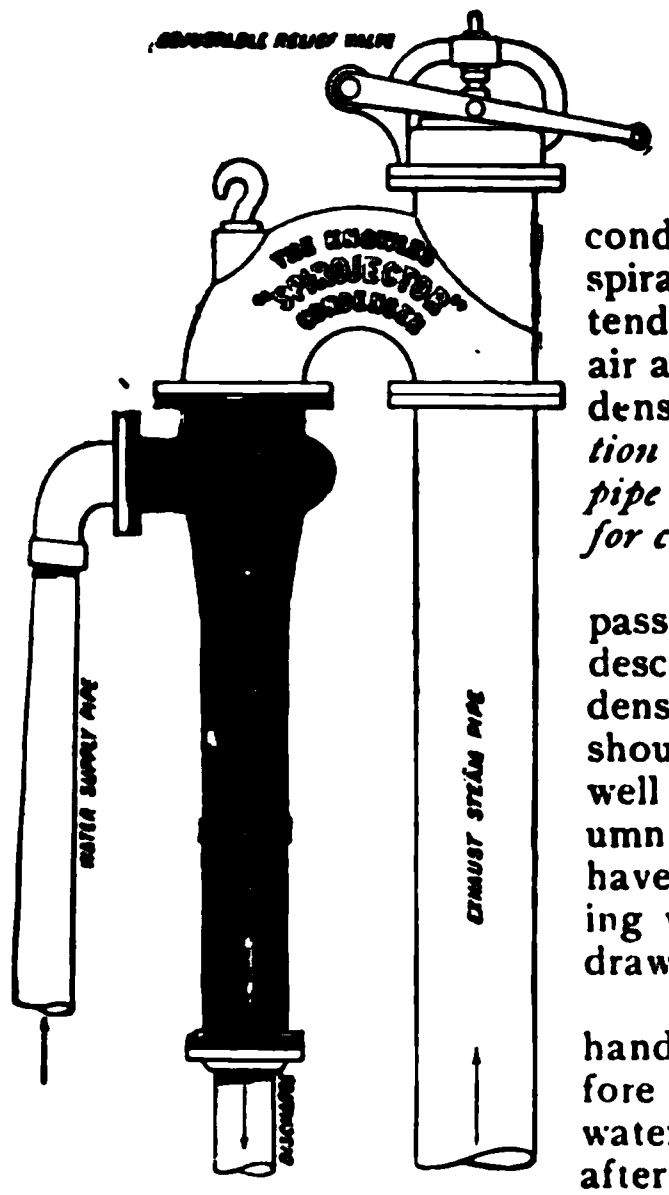
The Meyer cut-off attachment, shown in the cut on the opposite page, is only furnished when specially ordered, and is charged *extra*. *Cut shows radial valves*. Send for special catalogue of air compressing machinery.



THE KNOWLES PATENT "SPIROJECTOR" CONDENSE

SYPHONING ITS SUPPLY OF WATER FROM FLUME OR PENSTOCK.

KNOWLES PATENT SPIROJECTOR CONDENSER.

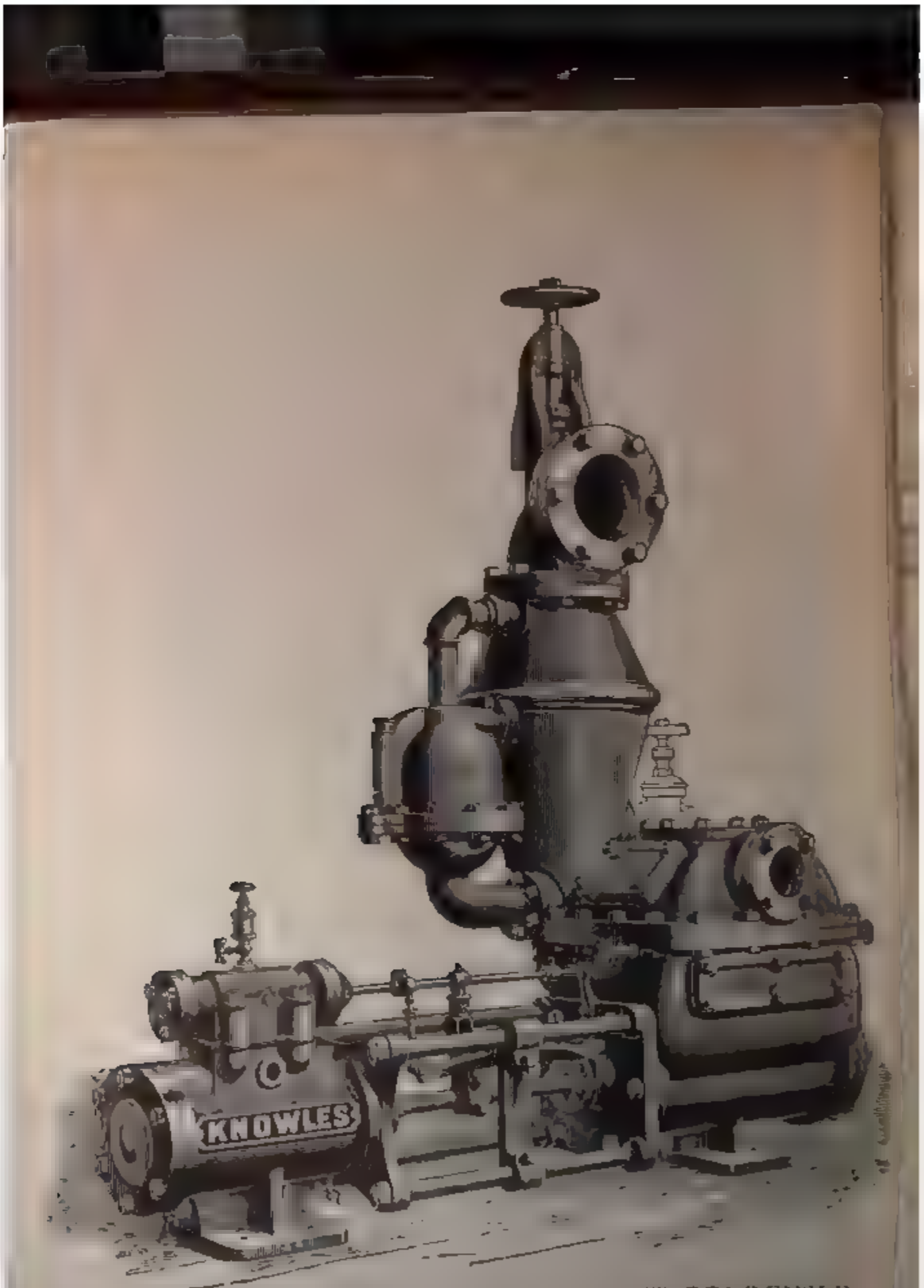


THE accompanying engraving illustrates our patent "Spirojector" Condenser, an improved form of the syphon system of jet condenser, and the best yet introduced. Particular attention is called to the arrangement of the cone in the upper part of the condenser, whereby the injection water is made to take a spiral or rotary direction in its downward flow. This action tends to produce a more perfect effect in drawing down the air and vapors through the narrow or middle part of the condenser. *That is to say, the whirling action given to the injection water as it passes through the condenser to the discharge-pipe produces the best results and with the use of less water for condensing the steam.*

The exhaust steam entering at the top of the condenser passes through the center of the cone and meets the rapidly descending spiral current of water and is immediately condensed. The "barometrical column" or discharge-pipe should be sufficiently long between the condenser and hot well (say a height of at least thirty feet) to support the column of water by the pressure of the atmosphere, and yet have the condenser itself kept clear for the rapidly descending water to carry the air down into the hot well after it is drawn through the condenser.

As shown, the injection water enters at the upper left-hand side of the condenser, circulating around the cone before taking the spiral action above described. The injection water can be syphoned from a tank, flume, or penstock after the vacuum is formed in the condenser, if the supply of water is not less than ten feet above the overflow-pipe of the hot well. If the supply of water is less than ten feet, then it is necessary to use a pump.

The engraving on opposite page represents our improved "Spirojector" Condenser as attached to a steam-engine and drawing the condensing water by "syphon" action from a tank, flume, or other water supply. This plan of supplying the condenser is available where the head of water is not less than ten feet above the overflow-pipe of the hot well. A supply-pipe of ample size should be used to convey the injection water from flume, penstock, or tank up to the condenser. On this pipe, at the most convenient point, must be provided a suitable injection-valve (as shown at "A") for regulating the quantity of water. A proper screen or strainer, with a large number of small holes, should be placed over the end of this pipe in the flume or tank, or, if preferred, one of our Special Box Strainers of ample size (as shown at "B") should be used on the pipe. The advantage of this form of strainer is the convenience with which it can be opened and cleaned. The cross-pipe and valve shown at "C" is for the purpose of starting the vacuum in the discharge-pipe of condenser; when sufficient vacuum is formed to cause the water to flow up the supply-pipe and through the condenser, then this starting valve ("C") should be closed, as the amount of injection water is regulated by the injection-valve "A." Once the condenser is properly started there is no trouble about holding continuously a steady and high vacuum; even if the head of water should fall to a point as low as ten feet above overflow of hot well (after the vacuum is once formed) the condenser will continue to syphon its water in sufficient quantity. Prices and *further particulars on application.* Send for special catalogue of condensing *apparatus.*



KNOWLES PATENT AIR PUMP AND JET CONDENSER.

REGULAR HORIZONTAL PATTERN

The engraving above represents a pump having 8 inch steam cylinder, 12 inch air cylinder, 12 inch stro

KNOWLES PATENT
AIR PUMP AND JET CONDENSER.

REGULAR HORIZONTAL PATTERN.

THE Knowles Independent Condensing Apparatus will save from twenty to thirty per cent. in steam when applied to non-condensing steam engines, or will give an increase of power of corresponding amount. It requires no expensive foundation, and can readily be attached, and placed in any position most convenient — under the engine room floor if desired.

Each pump is provided with composition-lined air cylinder, composition piston rod, specially vulcanized rubber valves, composition valve-seats and valve-bolts; valve-springs of phosphor-bronze. The piston of the air cylinder is made of composition, with adjustable fibrous packing.

TABLE OF SIZES, ETC.

AIR PUMP						CONDENSER		*Capacity, i.e., Weight of Steam used per Hour in Main Engine	Price	Telegraphic Code Word
Steam Cylinder	Air Cylinder	Stroke	Steam Pipe	Exhaust Pipe	Discharge Pipe	Injection Inlet	Exhaust Inlet			
Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Pounds		
5½	8	7	¾	1	3	2	TO SUIT EXHAUST PIPE OF ENGINE.	1560		Habeas
6	9	10	¾	1	4	3		2240		Habeck
6	10	12	¾	1	5	4		3340		Habendum
8	12	12	1	1¼	5	4		4800		Habile
8	14	12	1	1¼	6	5		6400		Hability
8	14	16	1	1¼	6	5		6540		Habitat
10	14	16	1¼	1½	6	5		6540		Habitual
10	16	16	1¼	1½	8	6		8540		Habitude
12	18	18	2	2½	8	6		10800		Habnab
12	18	24	2	2½	8	7		11000		Hackery
12	20	24	2	2½	10	7		13340		Hackle
14	20	24	2½	3	10	7		13340		Hackney
14	22	24	2½	3	10	8		16140		Hackster
14	24	24	2½	3	12	8		19200		Hadbote
16	26	24	2½	3	12	10		22540		Hadder
16	28	24	2½	3	12	10		26140		Hading

ALSO PATTERNS FOR SMALLER AND LARGER SIZES, OR OTHER COMBINATIONS.

*The above capacities are figured on a basis of condensing water not exceeding a temperature of 70 deg. F.; in case of colder or warmer water, smaller or larger sizes should be selected.

With each air pump and jet condenser we furnish a lubricator, drip-cocks, and full set of spanners and socket wrenches.

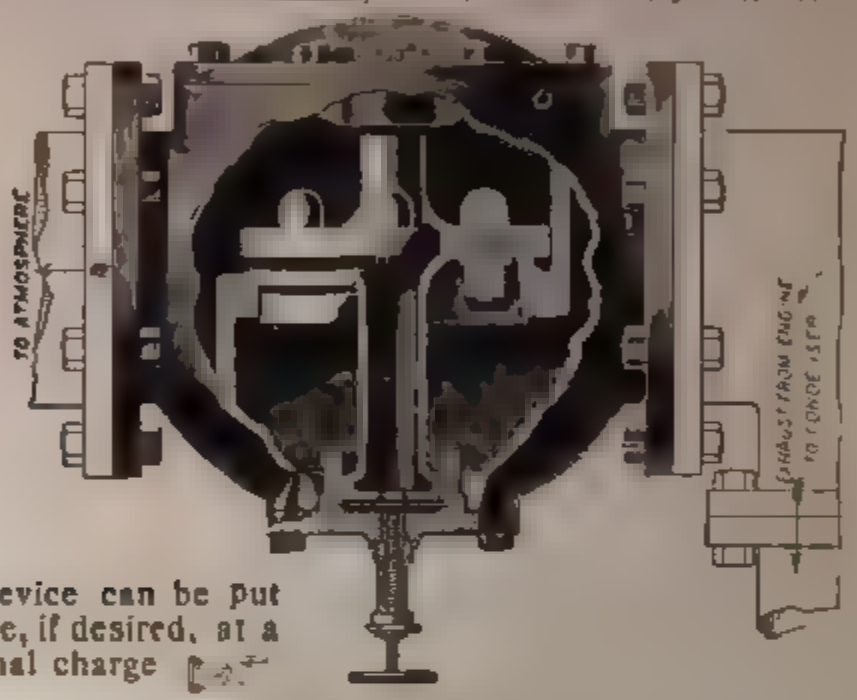
The engraving shows a gate valve on the injection pipe. This valve is not furnished with the condenser (unless specially ordered), but should always be placed on the injection pipe at the most convenient point near the condenser.

Send for the Knowles Special Catalogue of Air Pumps and Condensers

Send for Special Circular on Automatic Exhaust Relief Valves.

THE KNOWLES PATENT
AUTOMATIC EXHAUST RELIEF VALVES

Manufactured under our Patents of the following dates January 16, 1883 June 5, 1894, December [illegible]



This lifting device can be put on top of valve, if desired, at a slight additional charge

HORIZONTAL PATTERN

ARE specially designed for use with condensing engines. They allow the engine to exhaust instantly into the atmosphere in case of accident to the condensing apparatus, and are prompt and noiseless in their action

A safety device of this kind is needed in every steam power plant, whether the condensers are independent or directly connected to the engines Any condenser is liable to lose its vacuum by the partial or entire stoppage of the supply of injection water, or by the failure of the air pump or its attachments Under such conditions, the steam in the exhaust pipe accumulates pressure, and is liable to impede or stop the engine before a proper communication can be made to the atmosphere. The exhaust steam would probably find relief through the condenser and pump, but not without injuring the valves and packings, and, being restricted in its passage, it is liable to slow down the engine, and often cause serious damage.

The Knowles Relief Valve should be placed in a branch leading from the main exhaust pipe to the atmosphere. (NOTE —The usual practice is to make this branch and valve one size less diameter than the main exhaust pipe.) As long as a vacuum is maintained in the condenser, the relief valve remains tightly closed, but as soon as the vacuum is lost, the valve promptly opens and the engine exhausts into the atmosphere, and continues to run non-condensing until the vacuum is restored, when the valve closes automatically.

The special feature in the design of the Knowles Automatic Exhaust Relief Valve is the dash-pot, which allows the valve to open and close quietly (as an ordinary check valve would pound from the effect of the engine's intermittent exhaust) The facing of the Knowles Relief Valve is made of a special material which keeps the valve tight, but does not allow it to adhere to the seat

An attachment for permanently holding the valve wide open, when it becomes necessary to do this for any length of time, is included with each valve.

For Sizes, etc., see Following Pages

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HORIZONTAL AUTOMATIC EXHAUST RELIEF VALVE.

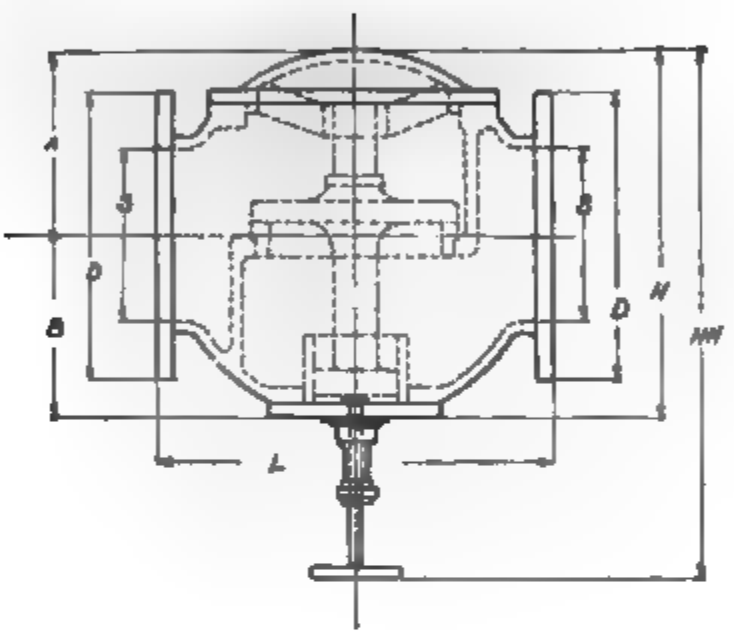

TABLE OF SIZES, ETC., IN INCHES.

D	L	H		A	B	NN	Thickness of Flanges	Diameter of Bolt Circle	Number and Size of Bolts	Arrangement of Bolts *	Telegraphic Code Word
Diameter of Flanges	Length	Width	Height	Height above Centre	Distance below Centre	Height over all					
9	19	9	12¾	6	5¼	18	⅝	7½	4 ⅝	two up	Maltraian
10	13½	11⅛	14⅓	7⅝	6¼	21⅛	⅝	8½	8 ⅝	two up	Maltraidos
11	15	12⅞	16⅝	8½	7⅛	23⅝	1 1/16	9½	8 ⅞	two up	Maltraigas
13⅜	18	17	18¾	10	8¼	28½	¾	11½	8—⅞	two up	Maltraigo
16	24	23	23⅜	12½	11⅜	30⅜	¾	14⅜	12—⅞	two up	Maltratado
19	26	25	27⅛	14⅝	12⅞	38	⅞	17	12—¾	two up	Maltrateis
21	32	29	31¼	16¼	15	42	1	18¾	12 ⅞	two up	Maltreut
23½	36	32	34¾	17⅝	16⅝	46½	1⅛	21¼	16—⅞	two up	Maltreated
25	42	36½	38¾	20	18⅛	52¼	1⅛	24¼	16—1	two up	Maltster
27½	48	41¾	42⅛	21⅛	21¼	57½	1⅜	25	20—1	two up	Maltusiano
29½	48	42⅜	43¾	21⅜	21⅞	59¼	1⅜	27¼	20—1	two up	Maltworm
31½	52	43¾	45¼	23½	22¼	62¼	1⅜	29¼	20—1	two up	Maluccisto
33¾	58	50	52	26	26	71½	1½	31⅝	24 1	two up	Maluccio
36	66	56	57½	28½	29	79⅛	1¾	33⅝	28—1	two up	Maluchas
38	73	60⅜	63⅛	31½	32	87¼	2	35½	28—1⅛	two up	Maluco

* The term "two up" means, that two bolts in upper part of flange are distant from the vertical centre line. No extra charge for drilling flanges, either drilled as per table above or according to a templet furnished us.

☞ If parties ordering valves do not specify drilling, we always send them with flanges undrilled.

Companion flanges for screw pipe, together with bolts, nuts, and gaskets, supplied at a small additional cost.

AUTOMATIC EXHAUST RELIEF VALVE

DOUBLE DASH-POT.

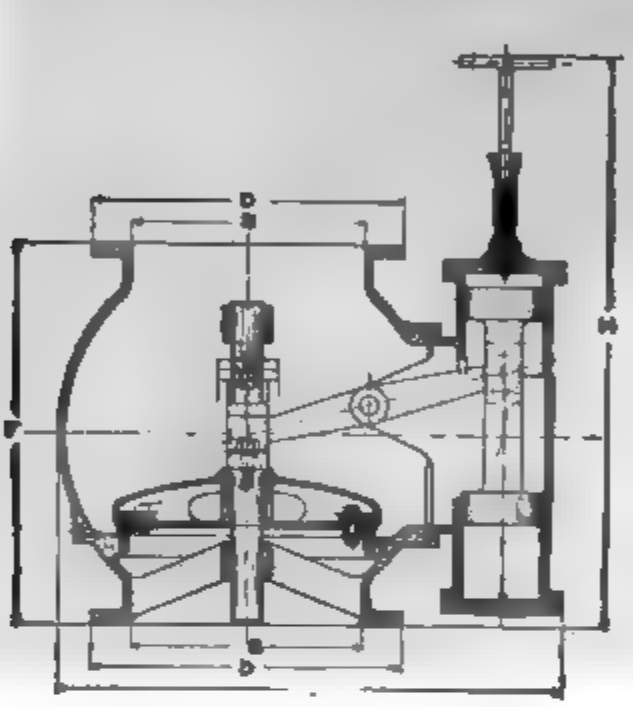

TABLE OF SIZES, ETC., IN INCHES.

S	D	F	L	H		Thickness of Flanges	Diameter of Bolt Circle	Number and Size of Bolts	Arrangement of Bolts	Telegraphic Code Word
Size	Diameter of Flanges	Height Face to Face	Length	Height	Width					
4	9	9½	14½	14⅛	8¼	⅝	7¼	4 – ⅝		Mamphula
5	10	11	15½	17	9¾	11/16	8 ½	8 – ⅝		Mamphulis
6	11	13	17½	20	1 ¼	11/16	9½	8 ⅝		Mamposteo
8	13½	16	21¼	25	10	¾	11¼	8 ⅝		Mampresets
10	16	17	24⅜	28⅝	18	⅞	14¼	12 ⅞		Mampreso
12	19	20	28½	30	20	⅞	17	12 ⅞		Mampsarus
14	21	23	32⅜	33 ¼	23½	1	18½	12 – ⅞	See	Mampuestos
16	23½	27	36 ¼	42	27½	1	21½	16 – ⅞	Below	Mamsell
18	25	30	41 ¼	45¼	1	1⅛	22¾	16 – 1		Mamuchus
20	27½	34	44½	51	34¼	1⅛	25	20 – 1		Mamudo
22	29½	36	49¼	50	36⅜	1⅛	27⅛	20 1		Mamurianus
24	31 ½	37	51	58	38¼	1⅛	29½	20 1		Mamurus
26	33¾	42	55	63	42	1½	31¾	24 – 1		Mamurra
28	36	46	53	67	47	1¾	33½	28 – 1		Mamurrarum
30	38	50	63	72	50	2	35½	28 – 1⅛		Mamutjak

Bolts are so arranged that two bolts nearest hand-wheel are equidistant from centre line passing through hand-wheel.

No extra charge for drilling flanges, whether drilled as per table above or according to a templet furnished us.

☞ If parties ordering valves do not specify drilling, we always send the valves with flanges undrilled.

Companion flanges for screw pipe, together with bolts, nuts, and gaskets, *supplied* at a small additional cost.

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ANGLE AUTOMATIC EXHAUST RELIEF VALVE.

DOUBLE DASH-POT.

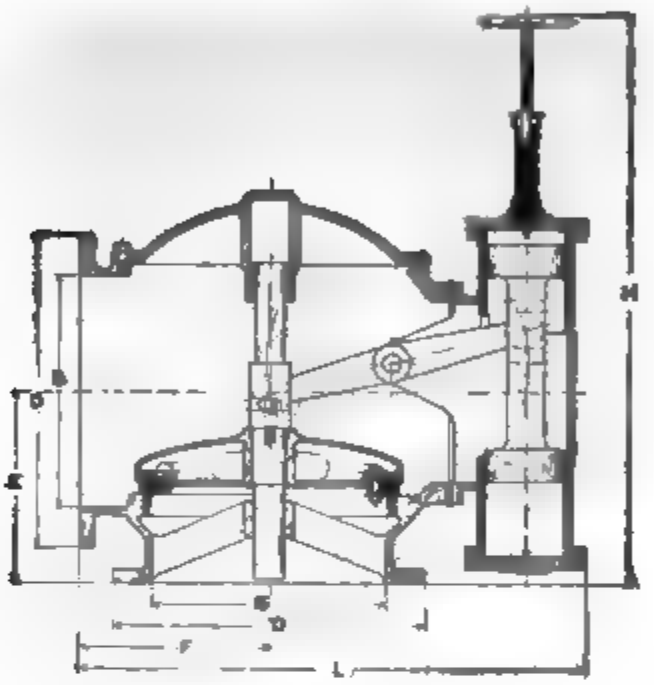


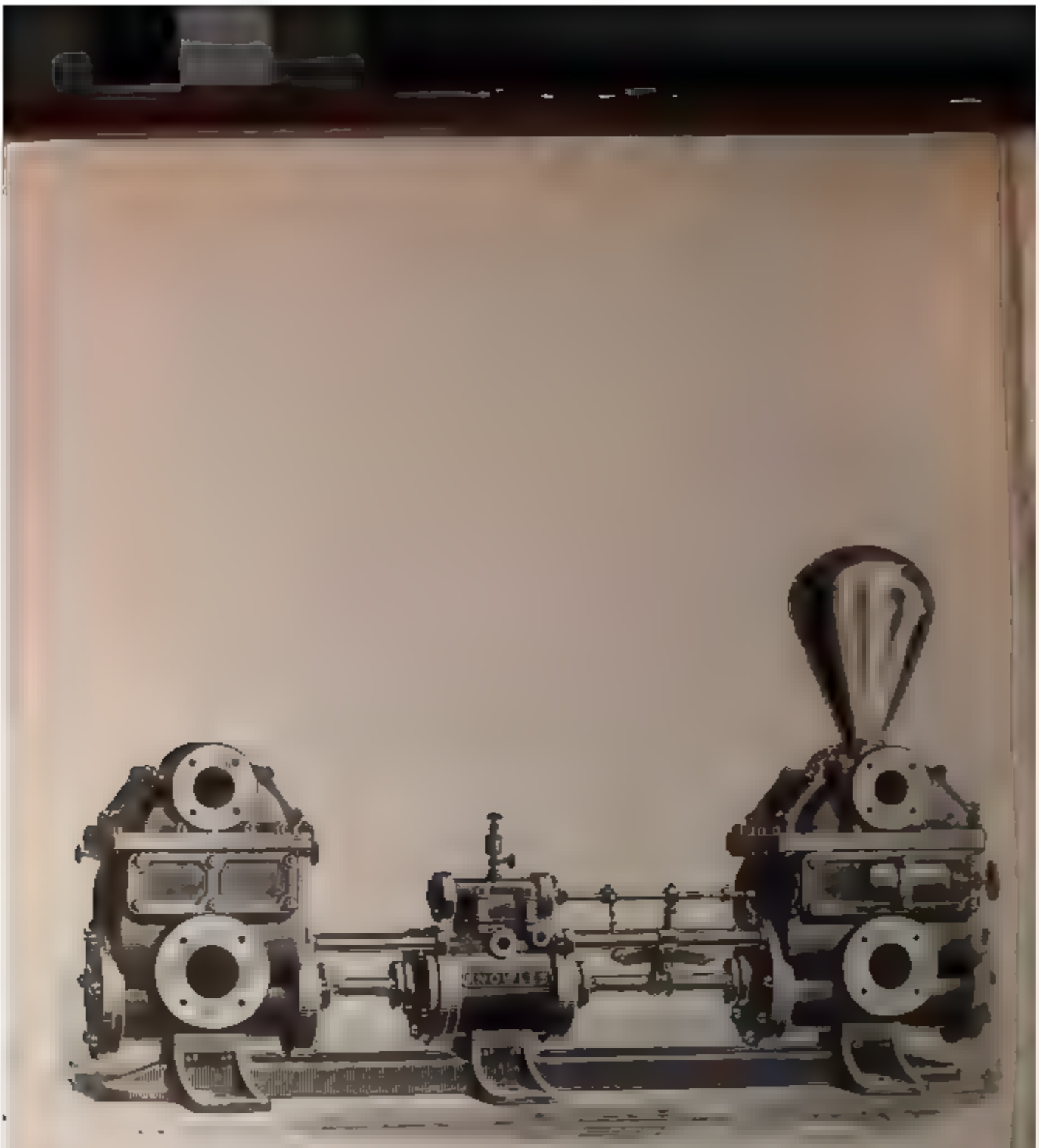
TABLE OF SIZES, ETC., IN INCHES.

S	D	L	H	E		F						
Size	Diameter of Flanges	Length	Height	Width	Height from Centre to Flange	Length from Centre to Flange	Thickness of Flanges	Diameter of Bolt Circle	Number and Size of Bolts	Arrangement of Bolts on Side Flange*	Arrangement of Bolts on Bottom Flange	Telegraphic Code Word
4	9	15½	14½	8¾	5¾	5¾	⅝	7½	4— ⅝	two up		Manacles
5	10	16½	17	9½	6⅝	6¼	1 1/16	8½	8— ⅝	two up		Manacling
6	11	18	20	11¾	6¾	6¼	1 1/16	9½	8— ⅝	two up		Manacou
8	13½	21¾	25	16	9	9	¾	11¾	8— ⅝	two up		Manaderas
10	16	24⅜	28⅝	18	9½	9½	⅞	14¼	12— ¾	two up		Manaethon
12	19	29½	30	20	11	11	⅞	17	12 ¾	two up		Managerial
14	21	33½	33¼	23½	12½	12½	1	18¾	12 ⅞	two up	See	Manahath
16	23½	36⅜	42	27 1/8	13½	13½	1	21¾	16 — ⅞	two up	Below	Manalgie
18	25	40¾	45¾	31	15	15	1 1/8	22¾	16 1	two up		Manatha
20	27½	44½	51	34½	17	17	1 1/8	25	20— 1	two up		Manalvo
22	29½	49¼	56	36¼	18	18	1¼	27¼	20— 1	two up		Manamina
24	31½	51	58	38¼	18½	18½	1¼	29½	20— 1	two up		Manaminis
26	33¾	55	63	42	21	21	1½	31¾	24 1	two up		Manaminum
28	36	59	67	46	23	23	1¾	33½	28 — 1	two up		Manancial
30	38	63	72	50	25	25	2	35½	28— 1 1/8	two up		Mananeases

* The term "two up" means, that two bolts in upper part of flange are equidistant from the vertical centre line. Bolts on bottom flange are so arranged that the two nearest hand-wheel are equidistant from centre line passing through hand-wheel. No extra charge for drilling flanges, whether drilled as per table above or according to a templet furnished us.

☞ If parties ordering valves do not specify drilling, we always send the valves with flanges undrilled.

Companion flanges *for screw pipe*, together with bolts, nuts, and gaskets, *supplied at a small additional cost.*



KNOWLES PATENT COMBINED AIR AND CIRCULATING PUMP.

REGULAR DOUBLE-ACTING PATTERN FOR SURFACE CONDENSERS

The engraving above represents a pump having 6-inch steam cylinder, 8-inch air cylinder, 8-inch water cylinder, and 7-inch stroke

KNOWLES PATENT
COMBINED AIR AND CIRCULATING PUMPS.

special combination of Air Pump with Circulating Pump is one of the most mpact and economical arrangements for surface condensers of stationary s or marine engines. The principal builders of surface condensers in this y use these pumps exclusively, and they are to be found in many of the electric light and power plants, where the surface system of condensers is red.

e engraving on opposite page shows the water cylinder provided with a valve for regulating the amount of circulating water where its temperature with the season of the year, as is usually the case. This valve is attached ps of the size illustrated and larger sizes. The air cylinders of ALL sizes are ed with a priming-valve at each end (as shown) for sealing the suction valves ming the pump.

ese pumps are composition fitted throughout, in the same manner as de- in the four preceding pages.

TABLE OF SIZES, ETC.

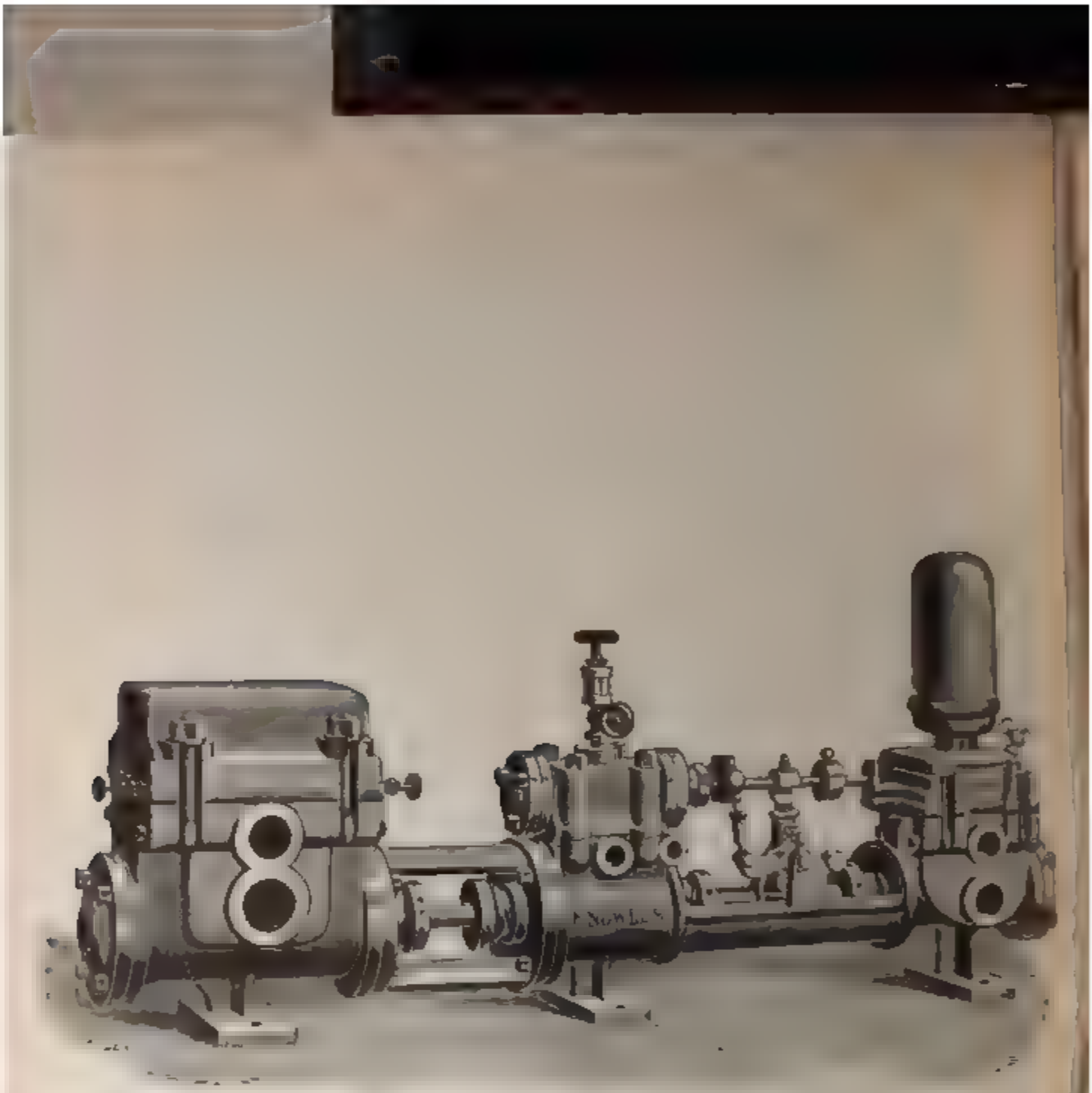
Air Cyl.	Water Cyl.	Stroke	Steam Pipe	Exha'st Pipe	Suction of Air Cyl.	Disc'ge of Air Cyl.	Suction of Water Cyl.	Disc'ge of Water Cyl.	Price.	Telegraphic Code Word
Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches		
3½	3½	4	½	¾	1½	1	1½	1		Hardy
4	4	4	½	¾	2	1½	2	1½		Haricot
5	5	5	½	¾	2	1½	2½	2		Harier
5½	5½	6	½	¾	2½	2	3	2½		Hariff
5½	5½	7	¾	1	3	2½	3	2½		Harlock
6	6	7	¾	1	3	2½	3½	3		Harlot
8	8	7	¾	1	4	3	4	3½		Harmonic
8	8	10	1	1¼	4	3½	5	4		Harmost
9	9	10	1	1¼	4	3½	5	4		Harness
10	10	12	1	1¼	5	4	6	5		Harpax
12	12	12	1¼	1½	5	4	8	6		Harper
14	14	12	2	2½	6	5	10	8		Harping
14	14	16	2	2½	6	5	10	8		Harrow
16	16	16	2½	3	8	6	10	10		Harshly
16	18	18	2½	3	8	6	12	10		Harslet
18	18	18	2½	3	10	8	12	10		Harvest

ALSO PATTERNS FOR LARGER SIZES, AND OTHER COMBINATIONS.

BOILER-FEED AND BILGE PUMPS ATTACHED WHEN REQUIRED.

also arrange our Combined Air and Circulating Pumps, when desired, mpound steam cylinders for the medium and larger sizes.

rtical Combined Air and Circulating Pumps to order; send for particulars.



KNOWLES PATENT COMBINED AIR AND BOILER FEED PUMP.

FOR STEAM YACHTS, LAUNCHES, TUGS, ETC.

The engraving above represents a pump having 4-inch steam cylinder, 6-inch air cylinder and 2 inch feed water cylinder and 5 inch stroke

KNOWLES PATENT

COMBINED AIR AND BOILER-FEED PUMPS.

FOR STEAM YACHTS, LAUNCHES, TUGS, ETC.

WE furnish a great many of these Combined Air and Boiler-feed Pumps for outboard pipe condensers, commonly used on small steam yachts and launches. One steam cylinder drives both the air and feed pumps, as shown in the engraving opposite. This makes a very compact and economical arrangement. The air cylinder draws the water of condensation from the condenser and discharges the same into the hot-well filter-tank, from which it is taken by the feed-water cylinder and forced into the boiler.

Both the air cylinder and feed-water cylinder have their linings, piston-rods, valve-seats, valve-bolts, and pistons made of composition. The valves of air cylinder are specially vulcanized rubber, and the valves of water cylinder are of composition or hard rubber, as preferred; valve-springs of phosphor-bronze; the pistons are packed with adjustable fibrous packing. The air cylinder is provided with a priming valve at each end, as shown in the engraving.

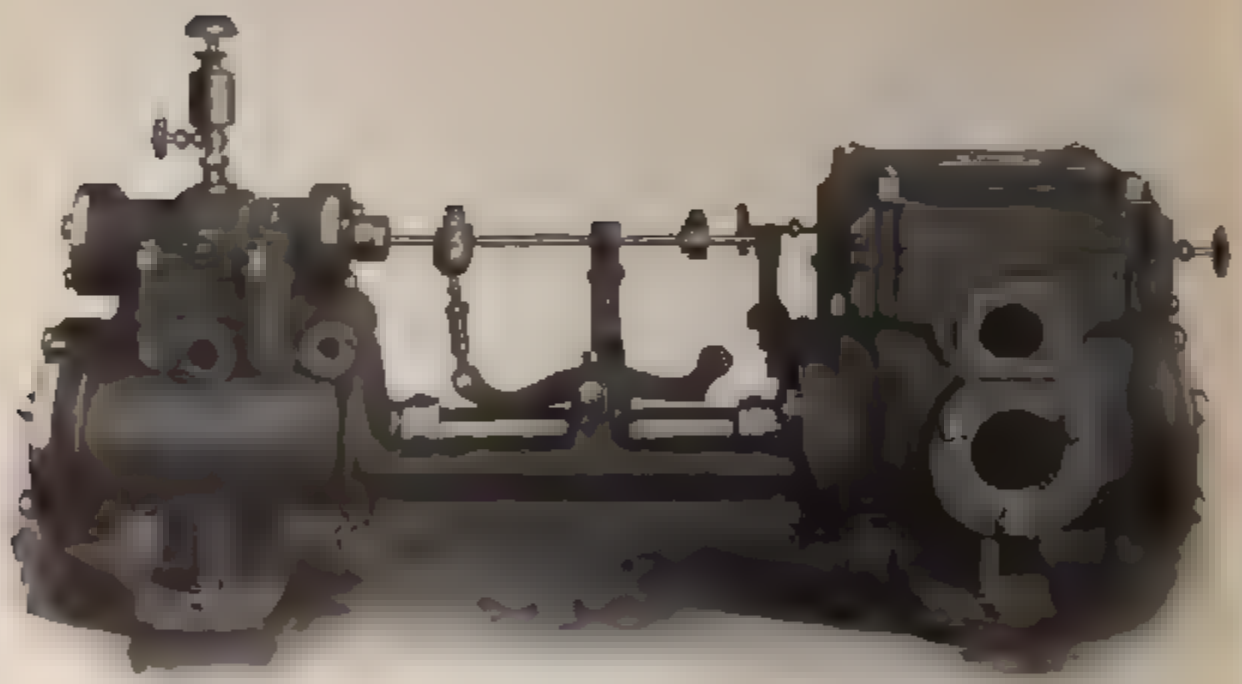
TABLE OF SIZES, ETC.

Steam Cyl.	Air Cyl.	Feed-water Cylinder	Stroke	Steam Pipe	Exha'st Pipe	Suction of Air Cyl.	Disc'ge of Air Cyl.	Suction of Feed Cyl.	Disc'ge of Feed Cyl.	Price	Telegraphic Code Word
Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches		
2½	3	1¼	3	¼	⅜	1	¾	½	⅜		Hashed
3	3½	1¼ to 1½	3	¼	⅜	1½	1	¾	½		Hassock
3½	3½	1¼ to 1¾	4	½	¾	1½	1	1¼	1		Haster
3½	4	1¼ to 1¾	4	½	¾	2	1½	1¼	1		Hasting
4	5	1¼ to 2	5	½	¾	2	1½	1¼	1		Hatband
5	5½	1½ to 2½	7	¾	1	2½	2	2	1½		Hatbox
5½	6	1½ to 2½	7	¾	1	3	2½	2	1½		Hatcase
6	8	2 to 2¾	7	¾	1	3½	3	2	1½		Hatchel
7½	8	2½ to 3¼	10	1	1¼	4	3½	2	1½		Hatchway
8	9	2½ to 3¼	10	1	1¼	4	3½	2	1½		Hateless
8	10	2½ to 3¼	12	1	1¼	5	4	2	1½		Hatter

ALSO PATTERNS FOR LARGER SIZES AND OTHER COMBINATIONS.

Vertical Combined Air and Boiler-feed Pumps, both single-acting and double-acting pattern. Particulars on application.

☞N. B.—An excellent way to connect the feed-water cylinder of these pumps is to run a small pipe from the discharge of the feed-pump to the hot-well or filter-tank, with a valve on said pipe to regulate the amount of water that is allowed to flow back to the tank. The suction-pipe should have no valve on it, so as not to prevent the free flow of water from the tank to feed-pump, and thus enable the water cylinder to *completely* fill at each and every stroke. By this arrangement the pump runs smoothly, and hot vapors cannot accumulate and prevent the proper working of the pump-valves. The amount of water fed to the boiler is regulated by the valve on the *discharge*-pipe leading to the tank—the wider open this valve is set, the greater the quantity of water flowing back to the tank, and, consequently, the less fed to the boiler.



KNOWLES PATENT STEAM HEATING VACUUM PUMP.

Size, 4 x 6 x 7

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KNOWLES PATENT

STEAM HEATING VACUUM PUMPS

DOUBLE-ACTING PISTON PATTERN.

THESE pumps were originally designed for maintaining a vacuum on steam heating systems to insure circulation and remove the hot water of condensation, but may be used for general purposes.

The air cylinder is provided with a brass lining which can be readily replaced when worn. The air piston is made of the best composition, and is provided with a special kind of fibrous packing, very hard, and not affected by steam or hot water. This packing is adjustable.

The valve seats, valve bolts and piston-rod stuffing boxes are made of the best composition. The piston-rod is of Tobin bronze. The valves in the air cylinder are made of the best quality of rubber, and are specially vulcanized very hard for this purpose.

Steam Cylinder. Inches.	Air Cylinder. Inches.	Stroke. Inches.	Style of Air End.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipe. Inches.	Discharge Pipe. Inches.	Telegraphic Code Word.
4	5	5	Flat Cap.	½	¾	2	1½	Hauch
4	6	7		¾	1	3	2	Hauddum
5½	8	7		¾	1	3	3	Hauender
6	8	12	Close Clearance.	¾	1	4	3½	Hauerite
6	9	10		¾	1	4	3½	Haughtily
6	10	12		¾	1	5	4	Hauhammer
8	10	12		1	1¼	5	4	Hauksbee
8	12	12		1	1¼	5	4	Hauloch
8	14	12		1	1¼	6	5	Haunches
8	14	16		1	1¼	6	5	Haupt
10	12	12		1¼	1½	5	4	Hauptallee
10	14	12		1¼	1½	6	5	Hauptanker
10	14	16		1¼	1½	6	5	Hauptbahn

ALSO PATTERNS FOR LARGER SIZES AND OTHER COMBINATIONS.

KNOWLES PATENT

HORIZONTAL DOUBLE-ACTING AIR PUMP.

FOR SURFACE AND KEEL CONDENSERS, ETC.

THE advantage of independent air pumps for marine and other steam engines is so well recognized that it is hardly necessary to say much on the subject here, except to mention the fact that the most modern practice is to have no pumps attached to the engine, thus relieving it from the drag or load of auxiliary connections of any kind. The advantage of forming a vacuum for the engine before the latter is started is greatly in favor of the independent system of air pumps; the speed of the pump can also be regulated to the requirements of the engine.

TABLE OF SIZES, ETC.

Steam Cylinder	Air Cylinder	Stroke	Steam Pipe	Exhaust Pipe	Suction Pipe	Delivery Pipe	Price	Telegraphic Code Word
Inches	Inches	Inches	Inches	Inches	Inches	Inches		
3	3½	3	¼	⅜	1½	1		Hairhung
3¼	4	4	½	¾	2	1½		Hairlace
3½	4½	4	½	¾	2	1½		Hairless
4	5	5	½	¾	2	1½		Haketin
4	6	7	½	¾	3	2½		Hakut
5½	7	7	¾	1	3	2½		Haler
5½	8	7	¾	1	3½	3		Halesia
6	8	10	¾	1	4	3½		Halfen
6	9	10	¾	1	4	3½		Halimas
6	10	12	¾	1	5	4		Haling
8	12	12	1	1¼	5	4		Halitus
8	14	12	1	1¼	6	5		Hallage
10	14	12	1¼	1½	6	5		Halliard
10	14	16	1¼	1½	6	5		Hallite
10	16	16	1¼	1½	8	6		Halloide
12	18	18	2	2½	10	8		Halloo
12	20	24	2	2½				Haloed

ALSO PATTERNS FOR LARGER SIZES AND OTHER COMBINATIONS OF CYLINDERS.

The linings, piston-rods, valve-seats and valve-bolts of the air cylinders are made of the best composition. The air pistons are also of composition packed with adjustable fibrous packing, and the valves are made of the best quality of rubber, specially vulcanized for the purpose; valve-springs of phosphor-bronze.

We also make Vertical Air Pumps of the double-acting type—particulars on application.

KNOWLES PATENT
CIRCULATING PUMPS.

FOR SURFACE CONDENSERS,

ALSO FOR WRECKING, BILGE AND BALLAST SERVICE.

THE table below gives a list of pumps, the cylinders of which are specially proportioned for circulating water through surface condensers, for wrecking, bilge and ballast service and similar light work.

The water cylinders are provided with composition linings reaching from head to head; the water-pistons are composition, packed with adjustable fibrous packing; the piston rods are also of composition; valves of the best quality rubber, specially vulcanized for the purpose; valve-seats of composition, valve-bolts of composition and valve-springs of phosphor-bronze.

TABLE OF SIZES, ETC.

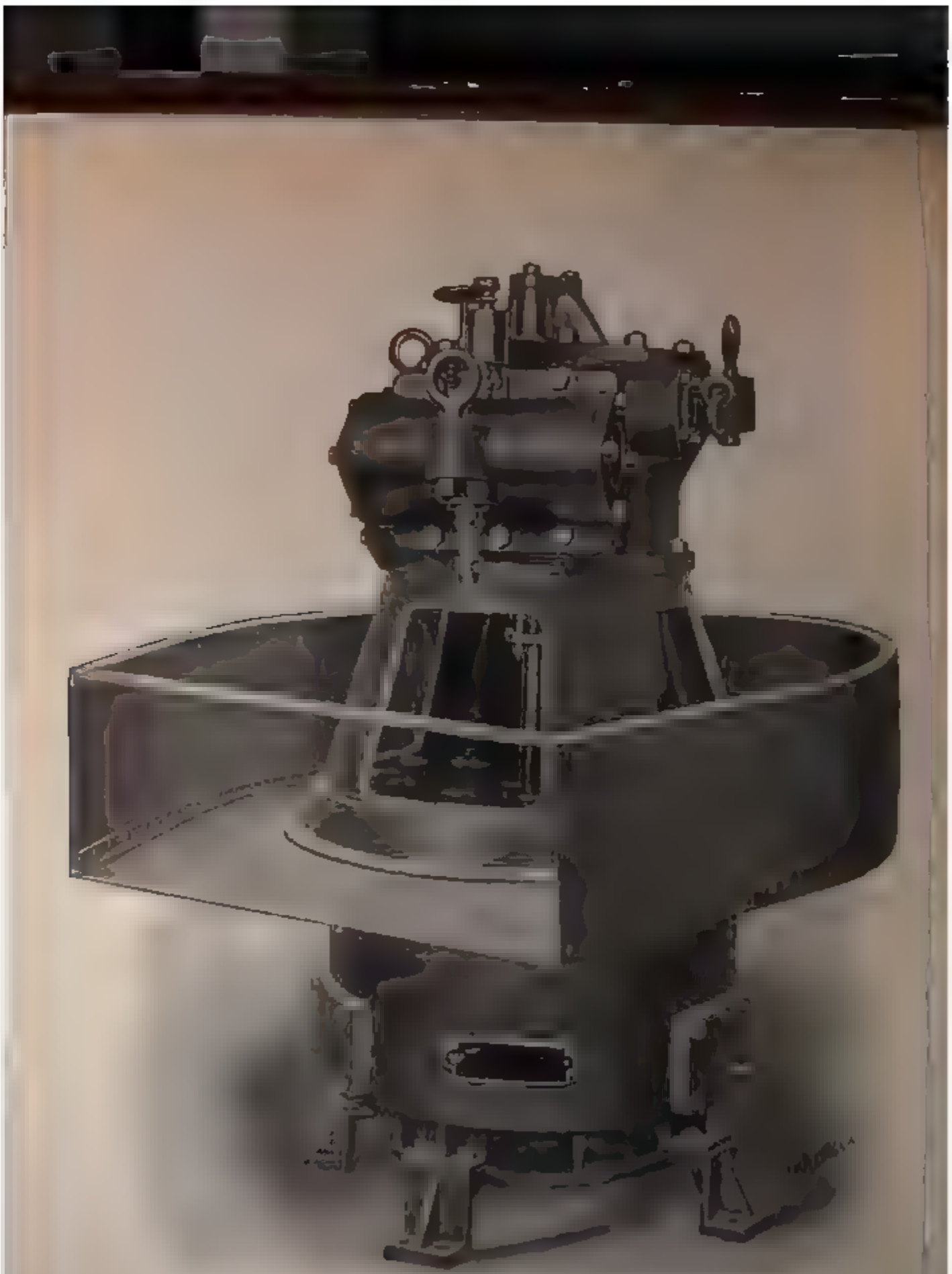
Steam Cylinder	Water Cylinder	Stroke	Gallons per Stroke	*Capacity per Minute at Ordinary Speed	Steam Pipe	Exhaust Pipe	Suction Pipe	Delivery Pipe	Price	Telegraphic Code Word
Inches	Inches	Inches	Inches	Gallons	Inches	Inches	Inches	Inches		
3	3½	3	.13	13	¼	⅜	1½	1		Hammel
3	4	3	.16	16	¼	⅜	1½	1		Hammock
3¼	4	4	.22	22	½	¾	2	1½		Hamous
4	5	5	.43	43	½	¾	2½	2		Hamper
4	6	7	.87	87	½	¾	3½	3		Hances
5½	7	7	1.16	116	¾	1	4	3½		Handball
5½	8	7	1.52	152	¾	1	4	3½		Handbook
5½	8	10	2.20	220	¾	1	5	4		Handed
6	9	10	2.75	275	¾	1	5	4		Handfast
6	10	12	4.08	408	¾	1	6	5		Hangby
8	12	12	5.87	587	1	1¼	8	6		Hangdog
8	14	12	8.00	800	1	1¼	10	8		Hangnail
10	14	12	8.00	800	1¼	1½	10	8		Hanker
10	14	16	10.67	800	1¼	1½	10	8		Hansel
10	16	16	13.92	1044	1¼	1½	10	10		Happen
12	18	18	19.83	1322	2	2½	12	10		Happily
12	18	24	26.44	1322	2	2½				Harbor
14	20	24	32.64	1632	2½	3				Harden
14	22	24	39.50	1975	2½	3				Hardish
16	24	24	47.00	2350	2½	3				Hardock

ALSO PATTERNS FOR LARGER SIZES AND OTHER COMBINATIONS OF CYLINDERS.

* The capacities given in this column are figured at a speed of 100 feet piston travel per minute, for pumps of 12-inch stroke and over. Pumps under 12-inch stroke are figured at 100 single strokes per minute for ordinary speed.

For salt water service, in the larger pumps (*i.e.*, size 5½x8x10 and over) the valves work on plates of composition, instead of the ordinary brass seats driven or screwed into iron castings, which is an important feature.

We also have patterns for VERTICAL PUMPS, which are very convenient where space is limited, as is often the case in the engine-rooms of steam vessels.



KNOWLES PATENT WRECKING PUMP.

Vertical Single-Acting Pattern.

VERTICAL WRECKING AND IRRIGATING PUMPS

Special Single-Acting Pattern.

THIS special design of Pump is a very convenient and inexpensive form of pump for Wrecking, Drainage or Irrigating purposes. These pumps are largely used by the Wrecking Companies of the Sea Coast and Lake Service; on the lower Mississippi River they are used for draining bottom lands, etc. They are light, portable, and have great pumping capacity. They are single-acting, but the flow of water from the pumps is practically constant, as the peculiar design and operation of pumps gives this effect. These pumps will handle large quantities of water with greater economy than centrifugal pumps, while they are much simpler and less likely to get out of order. They will not grind out and loose their suction power, causing excessive slippage, but will fully discharge their correct theoretical capacity of water at *any* speed—an impossibility with centrifugal and similar pumps.

A full and comparatively long stroke, with an even, smooth motion on the *up* as well as on the *down* stroke, are special features of this pump. The steam cylinder is *positive* and does not require any lever or other hand gear to work it "off the center." There are no belts to slip or complicated mechanism to get out of order.

These pumps are simply "lift" pumps and are not designed to elevate water above their discharge nozzles, but they will draw water any distance within the limit of "suction" power.

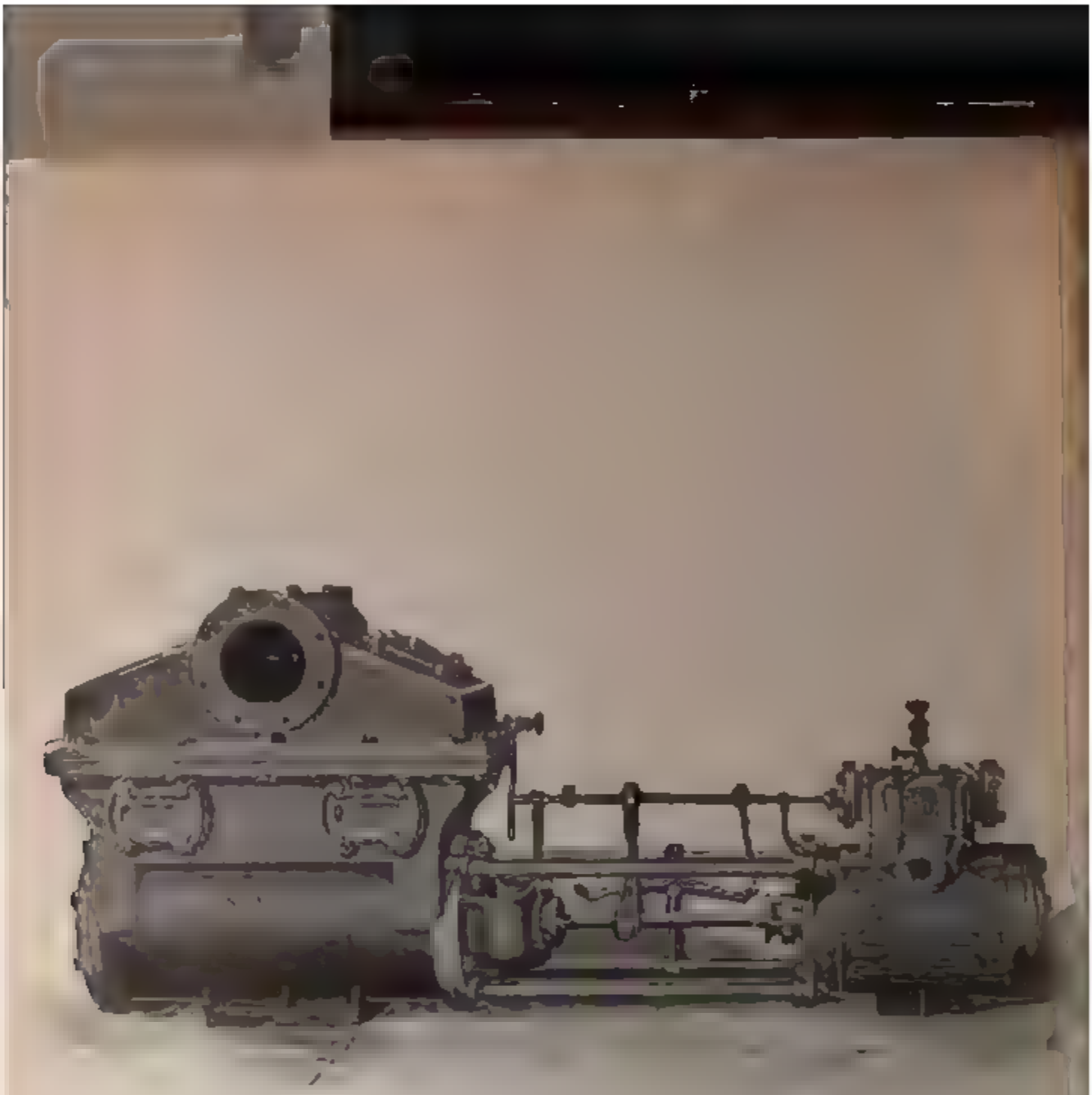
A *Wrecking Pump* has a set of foot valves below the bucket, and is "self contained." An *Irrigating Pump* has only one set of valves (these being in the pump bucket), and a foot valve must be provided for the lower end of the suction pipe, this foot valve not being included in the price of the pump. Irrigating Pumps may be used as Wrecking Pumps by placing a foot valve on the end of the suction pipes.

Steam Cylinder. Inches.	Water Cylinder. Inches.	Stroke. Inches.	Capacity per Minute at Ordinary Speed.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipe. Inches.	Telegraphic Code Word.
6	12	10	300 to 350 Gals.	¾	1	6	Ramblok
8	12	10	300 " 350 "	1	1½	6	Ramboango
10	20	12	850 " 1000 "	1¼	1½	10	Rambootan
14	25	12	1300 " 1600 "	2	2½	12	Rambooze
16	27	12	1500 " 1800 "	2½	3	12	Rambotim
18	30	10	1800 " 2200 "	2½	3	14	Raméal
18	30	12	1850 " 2250 "	2½	3	14	Rameform
18	30	16	1900 " 2300 "	2½	3	14	Rameggia
18	33	16	2300 " 2800 "	2½	3	16	Ramelles
20	36	16	2750 " 3250 "	3	4	18	Ramenashed
20	48	24	4800 " 5800 "	3	4	24	Ramenassen

ALSO PATTERNS FOR LARGER SIZES AND OTHER COMBINATIONS OF CYLINDERS.

The water cylinder is lined with brass; the piston rod, valve seats, etc., are also of brass; so that these pumps are adapted for salt as well as for fresh water. Valves of best vulcanized rubber are used, with the largest area possible to pass obstructions.

HORIZONTAL DOUBLE-ACTING WRECKING PUMPS, see page 61A.



KNOWLES PATENT VACUUM PUMP.

DIRECT-ACTING PATTERN

The lagging on steam cylinder barrel is furnished only when ordered, at a slight additional expense

KNOWLES PATENT
VACUUM PUMPS.

Direct-Acting Pattern.

FOR use in sugar refineries, plantation sugar houses, for condensed milk factories, glue factories, and for all kinds of apparatus used in concentrating extracts, chemicals, etc., these Improved Direct-Acting Vacuum Pumps are especially adapted. They combine all the latest improvements, and are simple, compact and very reliable. The workmanship and materials used in their construction is of the *best* character. Durability and freedom from accident or expensive repairs, are prominent features They occupy but little room and do not require expensive foundations, being self-contained. They can be transported without being taken apart, and there is but little expense necessary to connect them. They are adapted equally well to the "dry" as to the "wet" system, and will maintain a first class vacuum.

SIZES AND PRICES.

Steam Cylinder. Inches.	Air Cylinder. Inches.	Stroke. Inches.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipe. Inches.	Delivery Pipe. Inches.	Price.	REMARKS.
4	5	7	½	¾	3	3		
6	8	12	¾	1	5	5		
7	10	10	1	1¼	5	5		
8	10	12	1	1¼	6	6		
8	11	12	1	1¼	6	6		
10	12	16	1¼	1½	7	7		
10	14	16	1¼	1½	8	8		
12	16	16	2	2½	8	8		
14	18	24	2½	3	8	8		
16	20	24	2½	3	10	10		
16	22	24	2½	3	10	10		
18	24	24	3½	4	14	14		

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

The valve seats, valve bolts, lining, piston rod of the air cylinder are made of the best gun-metal composition. On the inside head of the air cylinder is provided a water-basin arranged so that the main stuffing-box is always sealed with water, thus preventing any possible leak of air through the gland to deteriorate the vacuum when the pump is in operation.

DOUBLE VACUUM PUMPS.

These pumps have two air cylinders, arranged with the steam cylinder between them. The pumps are adapted particularly for "double" or "triple effects," where one air cylinder is connected with the condenser of the "strike" pan, and the other air cylinder to the condenser of the last pan of the "double" or "triple effect."

SIZES AND PRICES:

Steam Cylinder. Inches.	Air Cylinder For Strike Pan Condenser. Inches.	Air Cylinder for "Effect" Condenser. Inches.	Stroke. Inches.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipes. Inches.	Delivery Pipes. Inches.	Price.
18	16	16	16	2½	3	8	8	
20	18	18	24	3½	4	8	8	
22	20	20	24	4	4½	10	10	
24	22	22	24	4	4½	10	10	
26	24	24	24	4	4½	12	12	

ALSO PATTERNS FOR SMALLER AND LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

The air cylinders have gun-metal composition linings, valve seats, valve bolts, piston rods The arrangement of water-basins for sealing the air cylinder stuffing-boxes are the same as in the above.

CRANK AND FLY-WHEEL VACUUM PUMPS, see next two pages also page 70.
COMBINED VACUUM AND WATER PUMPS, see pages 68, 69, and 71.

KNOWLES IMPROVED DUPLEX FLY-WHEEL VACUUM PUMP.

Size, 10x16x10.

The speed governor shown is furnished only when ordered, at a slight additional expense.

KNOWLES IMPROVED

DUPLEX FLY-WHEEL VACUUM PUMP.

THE cut on the opposite page shows our latest pattern Duplex Fly-Wheel Vacuum Pump. Owing to their perfectly uniform and positive length of stroke and consequent small clearance space in both steam and vacuum cylinders, these pumps are most efficient, both in producing high vacuum and in economy in steam consumption.

They are made in the most thorough manner and of the best materials. The Air Cylinders are lined with gun-metal composition. The piston rods, valve seats, and valve bolts are also of composition. The pistons of the Air Cylinders are of composition, packed with a special form of adjustable packing. The steam cylinders have plain D slide valves. The connecting rods, crossheads, and crank shaft are of the best forged iron. Each and every detail is carefully designed and adjusted for the best service. The cranks are set at right angles, consequently there is no "*dead centre*" and the motion is steady and uniform at any speed.

The design of our new pattern vacuum cylinder is such that the same pump may be used equally well for either the wet or dry system.

In the "wet system," all the water used for condensing passes through the pump, while in the "Dry System," the "Barometrical column" or leg pipe carries off the injection water by gravity from the bottom of the condenser without passing through the pump.

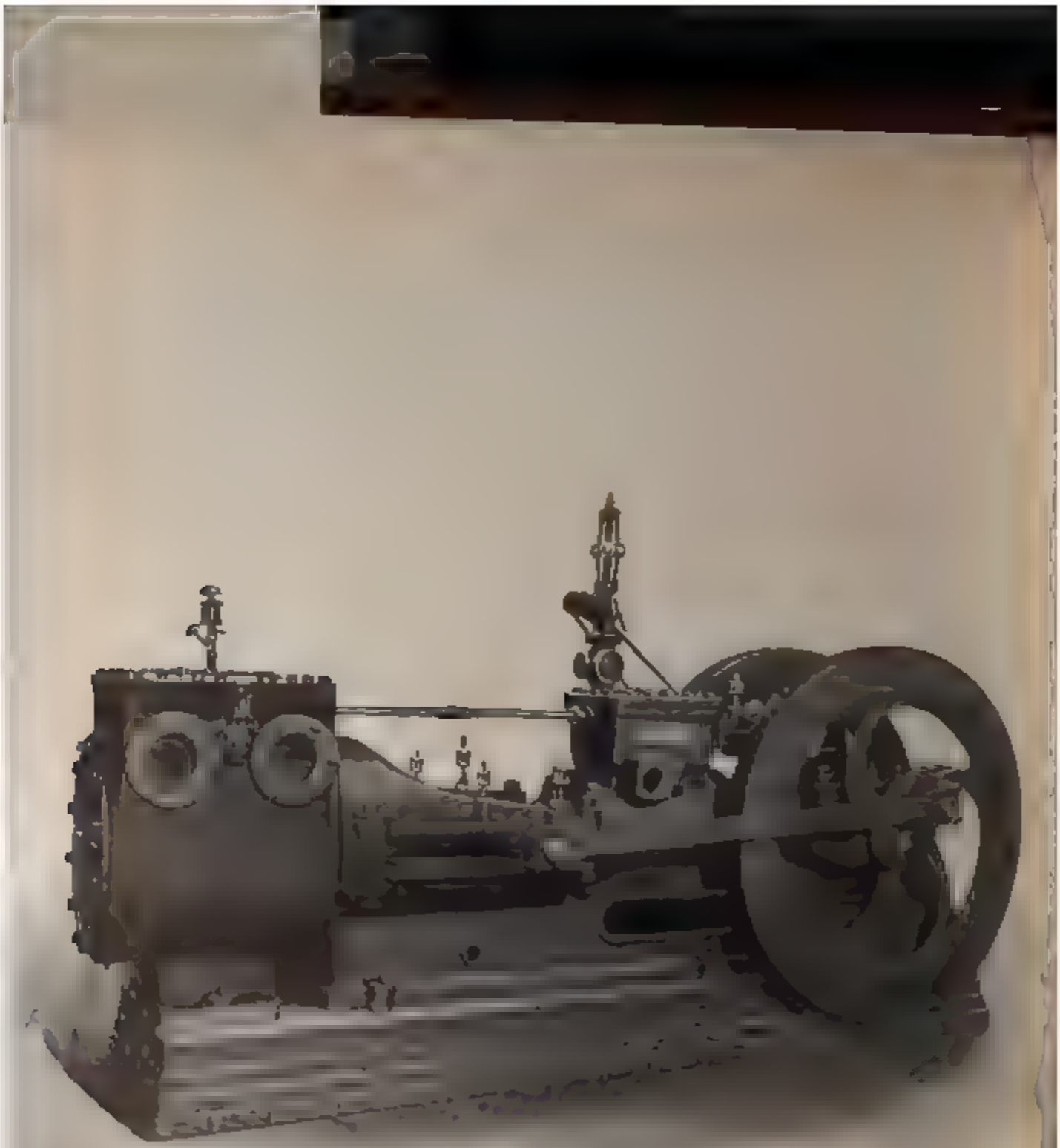
LIST OF SIZES, ETC.

Steam Cylinder	Vacuum Cylinder	Stroke	Steam Pipe.	Exhaust Pipe	Suction Pipe.	Discharge Pipe	Length.	Width.	Height	Telegraphic Code Word.
5	6	6	2	1½	5	5	85	45	40	Feague
6	8	6	2	1½	5	5	90	48½	40	Fealty
7	10	6	2½	2	6	6	95	50¾	42	Fearful
8	10	6	2½	2	6	6	95	51¾	45	Fearless
8	10	10	2½	2½	6	6	128¼	60	56	Feaster
8	12	10	2½	2½	6	6	128¼	60	56	Feasting
9	14	10	2½	2½	8	8	134	63	54	Feathered
9	12	10	2½	2½	6	6	128¼	60	60	Feathery
9	14	11	2½	2½	8	6	132½	67	51	Featness
10	14	11	2½	2½	8	6	132½	67	63	Featured
11	16	11	3	3	10	8	136	82½	47	Feaze
12	16	11	3	3	10	8	136	82½	47	Febrific
12	18	10	3	3	12	10	136	82½	47	Febrifuge
12	20	10	3	3	12	10	154	101	51	Febrile
14	18	10	3	3	12	10	136	82½	54	Fecial
14	20	10	3	3	12	10	154	101	44	Fecula
14	22	10	3	3	12	10	136	86½	44	Feculent
16	22	10	3½	3½	12	10	151½	86½	55	Fecund
18	24	10	3½	4	12	10	172½	92½	44	Fecundate

ALSO LARGER SIZES AND OTHER COMBINATIONS OF CYLINDERS.

The Governor shown in the cut is supplied only when ordered—at a slight additional expense.

☞ **Parties Ordering** will please inform us (1) if the vacuum pump is for "Wet" or "Dry" System and (2) what is the diameter of the Pan or Evaporator and the amount of heating surface in same; (3) what is the character of the material and quantity to be evaporated per hour in the evaporator; and (4) the average temperature of the injection water for the condenser.



SINGLE ROTATIVE DRY VACUUM PUMP.

These can also be used as blowers for air pressures not exceeding 15 lbs. per square inch.

KNOWLES IMPROVED
ROTATIVE DRY VACUUM PUMP.

THIS is a new form of vacuum pump of the type used for the dry system, and has been designed and constructed to meet requirements calling for pumps of large capacity with high degree of vacuum, such as in the case of sugar refineries and vacuum pans in general, for preserving processes, for removal of air from underneath covers in canning goods, and for central condensing systems.

This machine is built both of the single type and of the duplex type. It will be seen by the illustrations, both single and duplex, that the machines are compact, substantial and simple, with double-acting steam cylinders, and double-acting vacuum cylinders, the pistons operating in both being mounted on the same piston rod. The fly-wheels are of such weight as to admit of operation at very slow speed. No water is used inside the vacuum cylinders for cooling. The vacuum cylinders are cooled by means of water jackets either in the cylinder heads or in the barrels of cylinders. The suction valves of vacuum cylinder are positively operated by means of eccentrics, and the speed of the machine is only limited by the conditions limiting the speed of ordinary steam engines. The ordinary running speed of these machines is 100 revolutions per minute (for 18 inch stroke or less) and can be exceeded, depending upon length of stroke and the size of the machine. The fly-wheels are proportioned for a speed less than 100 revolutions per minute and the lower speeds may be obtained by adjusting the governor to the speed required. As no water is admitted to the inside of the vacuum cylinders no difficulty is encountered in removing it at the end of stroke, thus admitting of high rotative speed, while most rotative dry vacuum pumps of other manufacturers employing the ordinary suction and delivery valves, require water injected inside the vacuum cylinders to keep the cylinders cool and to seal the valves, thus requiring these pumps to run at a slow rate of speed so that the water can be discharged as the pump approaches the end of its stroke. The result is that a machine has to be employed practically double the size required if one of our rotative dry vacuum pumps, with mechanically operated suction valves is used.

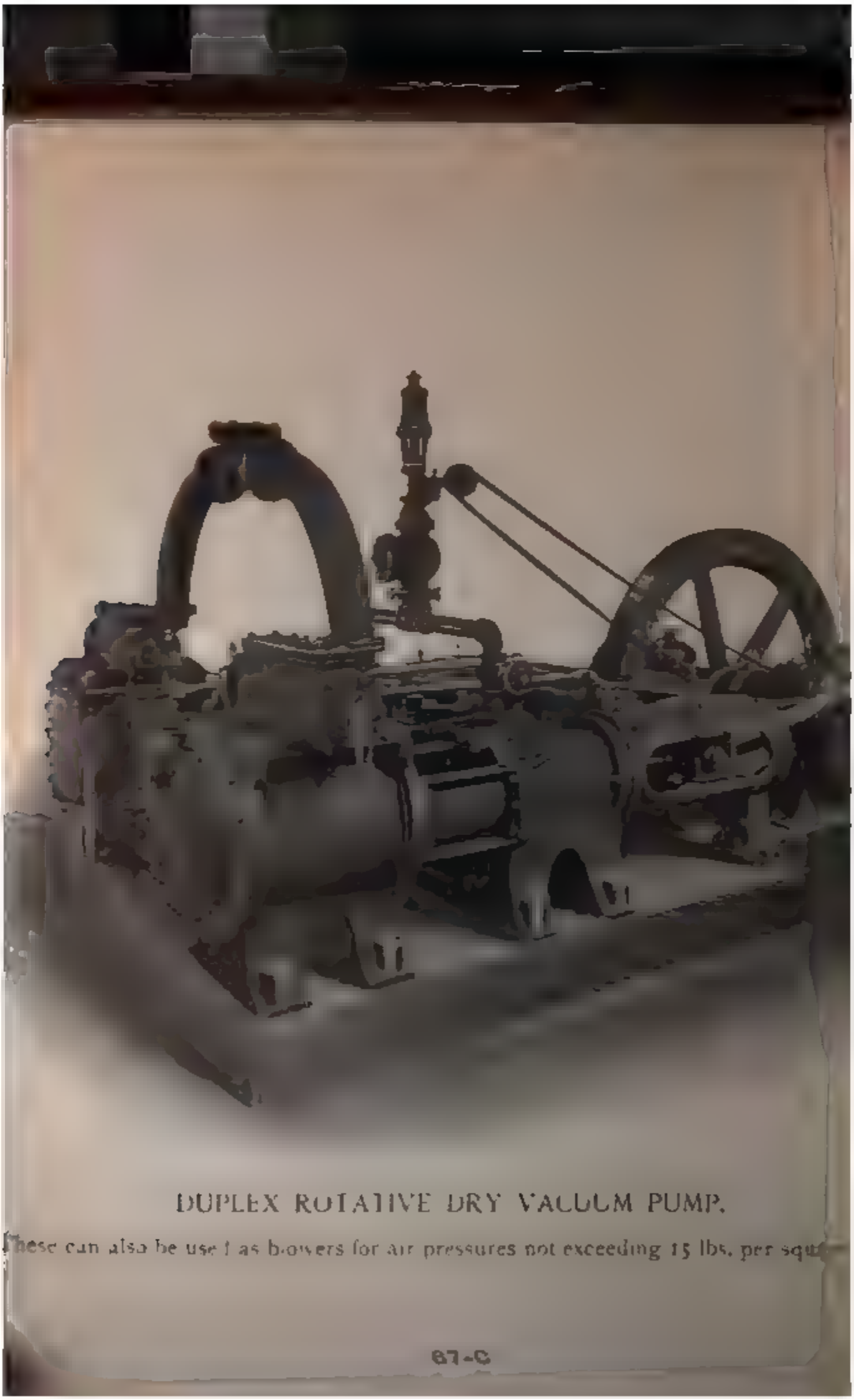
For high steam pressures we provide the steam cylinders with Meyer cut-off valves, at extra price, producing a high economy in steam consumption.

The type of suction valves employed in the vacuum cylinders depends upon the size of cylinders. The smaller machines have valves of the slide valve type and the larger machines rotary valves of the Corliss type. The ports are of very liberal size so as to offer the least possible friction to the vapors handled. The suction valves, being mechanically moved, open promptly to the full extent and offer no obstruction to the entrance of the vapors into the vacuum cylinders, instead of compelling the vapor to overcome the tension of the suction valve springs before the suction valves can open, as in the ordinary type of vacuum pump. The design of the valves in the vacuum cylinders is such that all vapor remaining in the clearance space, at the end of the stroke of the vacuum piston is removed by means of an equalizing port in the valve, which connects the two opposite ends of the vacuum cylinder together when the piston is at the end of its stroke. The result of this is, that the vapors collected in the clearance space in front of the piston at atmospheric pressure, pass back into the large vacuum space at the back of the piston, the pressure on the two sides of the vacuum piston being thus equalized and reduced to very nearly that maintained in the suction pipe, so that when the piston begins to make its return stroke, instead of the clearance space being filled with vapor at atmospheric pressure, which would expand and prevent the immediate production of a complete vacuum, work begins at once and practically the full displacement of the vacuum, piston is effective at each stroke.

One of the most important features of this machine is that, although it may be run at constant speed, the steam consumption in driving it is in proportion to the work done. The steam and vacuum cylinders are made of close grained cast iron, as hard as can be machined. Steam and vacuum pistons are of cast iron, with packing rings, and both pistons are machined on the outside. The connecting rods are of best open hearth forged steel, arranged with special adjustments. The steam valves are of the common D type, fitted with Meyer cut-off when specially ordered. In this case the steam valve consists of two parts, the main and distributing valves. When the Meyer cut-off is used, the point of cut-off is indicated by a pointer and scale, and the point of cut-off is adjusted by means of a hand wheel. The valve gear is a modification of the eccentric motion giving a quicker movement of the valves than is possible with the ordinary eccentric motion. The beds of both the single and duplex types are designed to resist and withstand the severest strains. The main bearings have broad surfaces, with adjustments for taking up wear, and are heavily babbitted. The quality of material and workmanship employed on these machines is of the best, and everything is subjected to a rigid test and inspection under conditions as nearly approaching the working conditions as possible, before leaving the factory.

Every machine is provided with centrifugal speed governor, and with oiling device.

For illustrations see pages 67-A and 67-C. For sizes see page 67-D.



DUPLEX ROTATIVE DRY VACUUM PUMP.

These can also be used as blowers for air pressures not exceeding 15 lbs. per squ

SINGLE ROTATIVE DRY VACUUM PUMPS.

Diam. of Steam Cylin.	Diam. of Pump Cylin.	Length of Stroke	Displacement in Cubic Feet per Minute.		Diam. of Steam Pipe.	Diam. of Exhaust Pipe.	Diam. of Air Inlet Pipe.	Diam. of Air Outlet Pipe	Space Occupied			Telegraphic Code Word.
									Length.	Width.	Height	
Ins.	Ins.	Ins.	Cu. Ft.	Revs.	Ins.	Ins.	Ins.	Ins	Ins	Ins	Ins	
6	8	7	40	100	1	1¼	2	2	[illegible]	[illegible]	[illegible]	Liebesellig
6	10	8	72	100	1	1¼	2½	2½	[illegible]	[illegible]	[illegible]	Liebesgeier
6	10	10	90	100	1	1¼	2½	2½	[illegible]	[illegible]	[illegible]	Liebesgeist
6	12	12	157	100	1	1½	3½	3½	[illegible]	[illegible]	[illegible]	Liebesheil
8	10	12	109	100	1½	2½	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Liebeshof
8	12	12	157	100	1½	2½	3½	[illegible]	[illegible]	[illegible]	[illegible]	Liebeskuss
8	14	12	213	100	1½	2½	4	4	[illegible]	[illegible]	[illegible]	Liebeslohn
8	16	12	279	100	1½	2½	4	4	[illegible]	[illegible]	[illegible]	Liebesluft
10	16	12	279	100	2	3	4	4	[illegible]	[illegible]	[illegible]	Liebesnacht
10	18	18	530	100	2	3	[illegible]	5	144	[illegible]	48	Liebesnot
12	18	18	530	100	2½	3½	[illegible]	[illegible]	144	[illegible]	48	Liebesnutz
10	22	18	792	100	2	3	[illegible]	[illegible]	144	[illegible]	48	Liebesrath
12	22	18	792	100	2½	3½	[illegible]	[illegible]	144	[illegible]	48	Liebesraub
12	24	18	942	100	2½	3½	[illegible]	[illegible]	144	[illegible]	48	Liebesspeise
14	22	18	792	100	3	4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Liebestraf
14	24	18	942	100	3	4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Liebesstrom

Size of openings are designed for short lengths of pipe. Size of pipe should be increased for greater lengths, and reduced near the pump if necessary

We furnish at extra price special foundation bed plates, used as coping and foundation bolts and Russia Iron lagging.

For description see page 67-B.

DUPLEX ROTATIVE DRY VACUUM PUMPS.

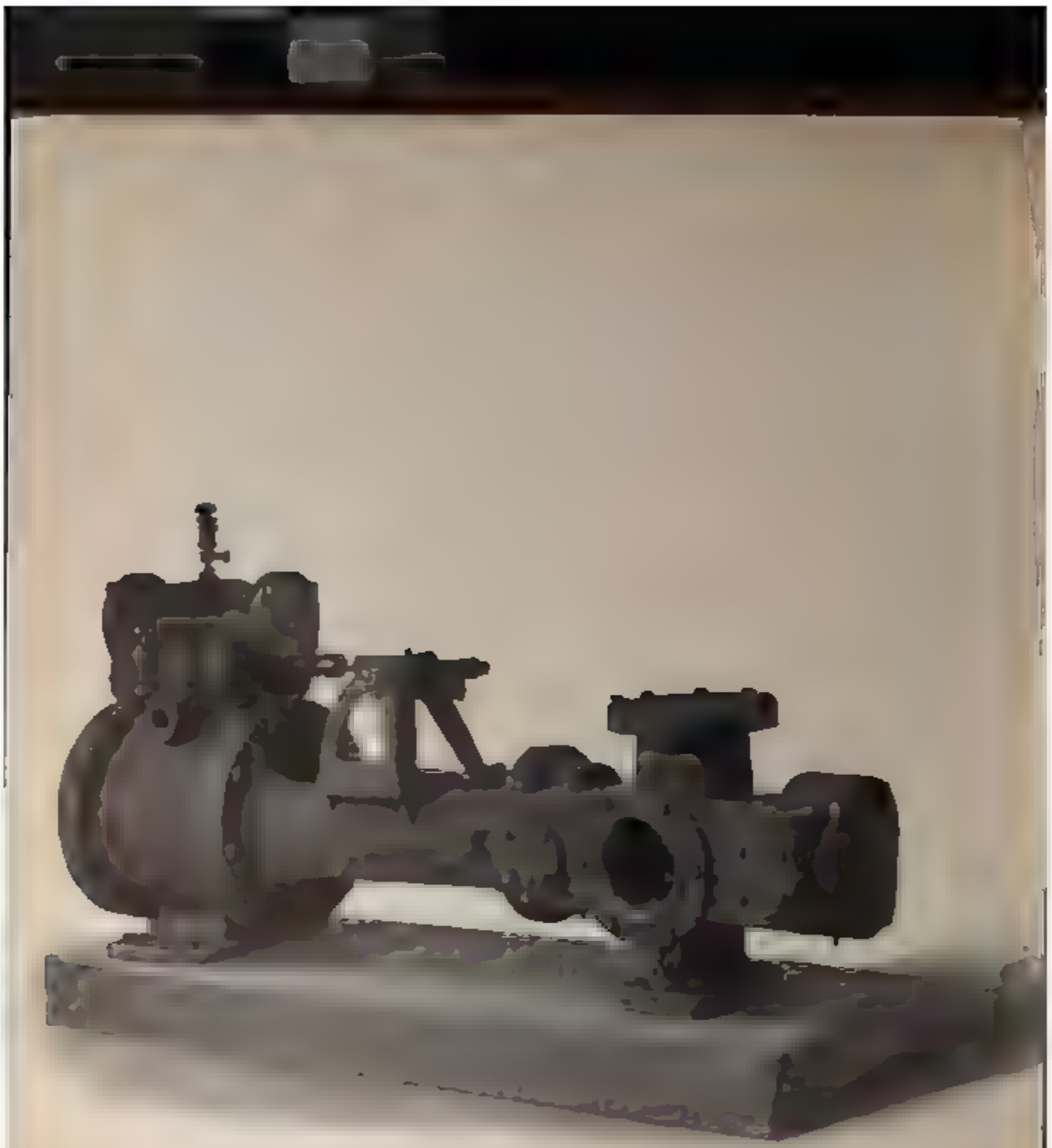
6	10	12	218	100	1½	2	4½	[illegible]	[illegible]	[illegible]	[illegible]	Liebam
8	12	12	314	100	2	2	5	[illegible]	[illegible]	[illegible]	[illegible]	Liebert
8	14	12	427	100	2	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Liebfrau
10	16	12	558	100	2½	3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Liebfrau
10	16	18	837	100	2½	3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Liebfrau
10	18	18	1060	100	2½	3	7	7	[illegible]	[illegible]	[illegible]	Liebfrau
12	16	18	837	100	3½	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Liebfrau
12	18	18	1060	100	3½	[illegible]	7	7	[illegible]	[illegible]	[illegible]	Liebfrau
12	20	18	1309	100	3½	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Liebfrau
12	22	18	1584	100	3½	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Liebfrau
12	24	18	1885	100	3½	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Liebfrau
14	20	18	1309	100	4	4½	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Liebfrau
14	22	18	1584	100	4	4½	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Liebfrau
14	24	18	1885	100	4	4½	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Liebfrau
14	30	18	2945	100	4	4½	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Liebfrau
16	30	18	2945	100	4½	5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Liebfrau
16	20	24	1396	80	5	[illegible]	8	[illegible]	[illegible]	[illegible]	[illegible]	Liebfrau
18	22	24	1684	80	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Liebfrau
18	24	24	2010	80	[illegible]	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Liebfrau

Sizes of openings are designed for short lengths of pipe. Size of pipe should be increased for greater lengths, and reduced near the pump if necessary.

We furnish at extra price foundation bolts and Russia Iron lagging.

Duplex pumps are made in three types: 12 inch stroke with bed plates under entire pump, with steam and vacuum cylinders mounted on this bed plate: 18 inch stroke type as per cut; 24 inch stroke pumps are of our heavy type design, specially made.

For description see page 67-B.



THE KNOWLES MAGMA PUMP.

Size, 16 x 7 x 12.

THE KNOWLES "MAGMA" PUMP.

"HE Knowles "Magma" Pump is illustrated on the opposite page. This pump is largely used in sugar houses to move the thick semi-fluids which require to be handled in connection with such work. For such service it is important that the pump be made with extra rge passageways for the liquid, and with the smallest possible number of working parts in e pump cylinder. To meet these requirements the Knowles "Magma" pump is constructed ith a large suction opening, usually larger than the pump cylinder bore, opening downward rectly into the centre of the pump cylinder. There are no suction valves in the pump. The mp piston travels across the large suction inlet, and after this opening is closed, all the aterial remaining between the pump piston and the cylinder head is expelled through a ecial form of discharge valve arranged to give a particularly large and free opening. With is type of pump it is essential that the liquid handled should flow to the pump under a head.

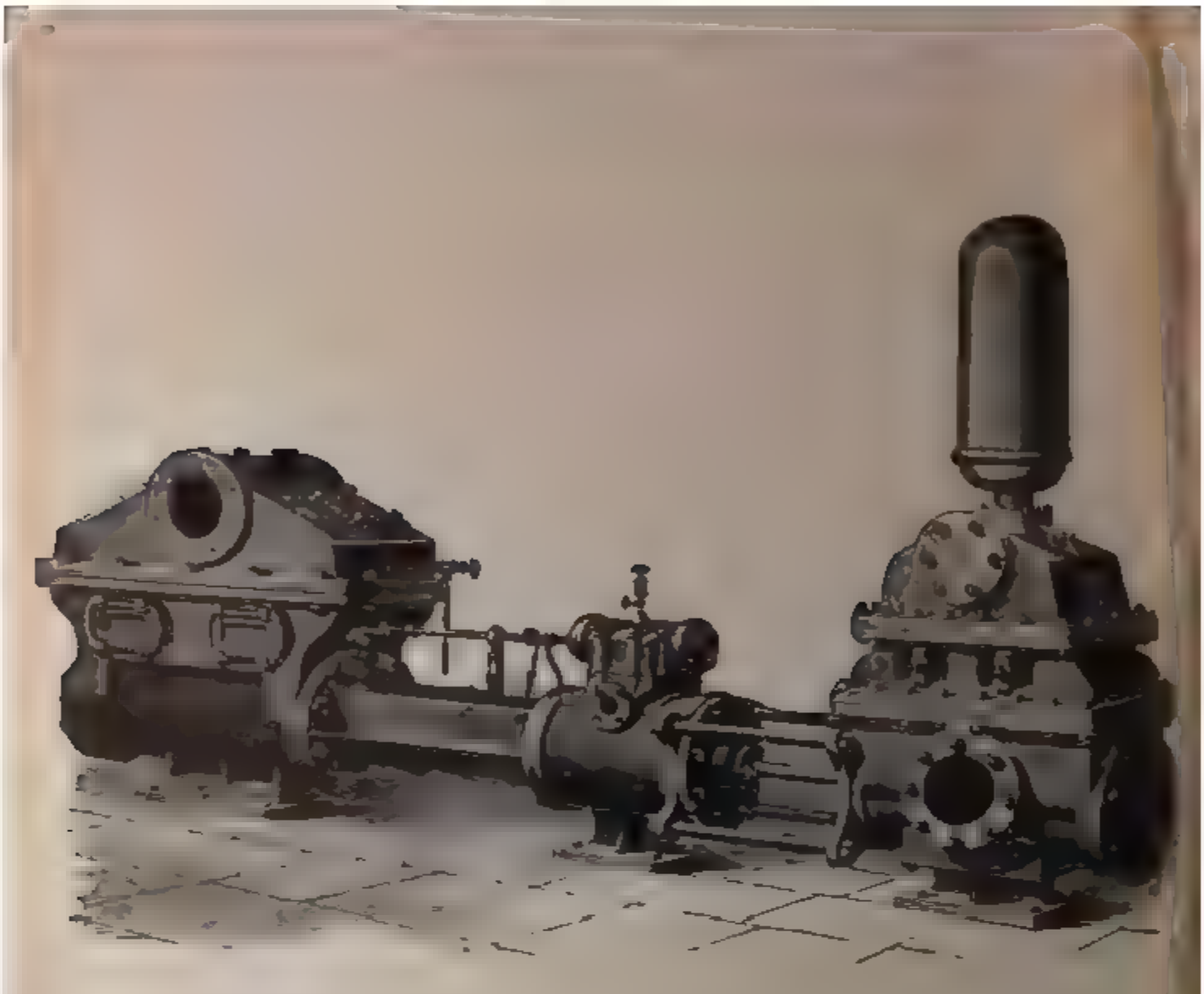
The same features that render this pump so particularly desirable for sugar house work, ake it equally suitable for handling any other semi-fluid material. It will successfully pump ap, whitelead, printer's ink, tar, etc., etc.

Steam Cylinder	Pump Cylinder	Stroke	Steam	Exhaust	Suction	Discharge	Telegraphic Code Word.
6	5	12	¾	1	6	5	Icelle
8	5	10	1	1½	6	5	Icelos
8	5	12	1	1½	6	5	Icenes
8	6	12	1	1½	7	6	Icequake
10	6	12	1¼	1½	7	6	Icerimus
10	7	12	1¼	1½	8	7	Icerunt
10	8	12	1¼	1½	10	8	Icespar
12	6	12	1½	2½	7	6	Ichabod
12	7	12	1½	2½	8	7	Ichnanthe
12	8	12	1½	2½	10	8	Ichnestome
14	7	12	2	3	8	7	Ichneumia
14	8	12	2	3	10	8	Ichneumon
16	7	12	2	3	8	7	Ichneute
16	8	12	2	3	10	8	Ichnobates
14	10	18	2	3	12	10	Ichnode
18	10	18	2½	3½	12	10	Ichnolite
20	10	18	3	4	12	10	Ichnology
18	10	24	2½	3½	12	10	Ichnusa
20	10	24	3	4	12	10	Ichonuphis

TAIL PUMPS.

We also have patterns for "Tail Pumps" similar in design to the above, used for removing ne material from triple effect or evaporators. As these pumps have to work against a vacuum n the suction, they are fitted with basin heads, with "drowned" stuffing boxes on the pump ads. Each pump has *two* discharge openings.

Steam Cylinder	Pump Cylinder	Stroke	Steam	Exhaust	Suction	Discharge	Telegraphic Code Word
5½	4	12	½	¾	3	1¼	Icoglan
6	5	12	¾	1	3	1½	Icolmkill
8	6	12	1	1½	4	2	Iconibus
8	7	12	1	1½	4	3	Iconiche



KNOWLES COMBINED VACUUM AND WATER PUMP.

Direct-Acting Pattern.

KNOWLES PATENT

COMBINED VACUUM & WATER PUMP.

Direct-Acting Pattern.

THIS compact combination of our Improved Direct-Acting Vacuum Pump with a water pump, for use in connection with the condensing apparatus of vacuum pans, etc., has met with great success in Cuba, San Domingo, Mexico, South America, Sandwich Islands, and other sugar-growing countries. They are also largely used in the sugar plantations of the Southern States, and in the condensed-milk factories, grape-sugar refineries and glue works of the North and West. These pumps are very efficient in operation and will maintain a *steady* and high vacuum, and will operate as

PERFECTLY ON THE "WET" AS ON THE "DRY" SYSTEM.

When connected with a vacuum pan working on the "dry" system, the water cylinder of the pump is arranged to deliver the injection water to the tank that supplies the condenser, or, if preferred, to the condenser direct. In Cuba and other places where the "cooling tower" is in vogue (the injection water being used over and over again), the water cylinder is arranged to take the warm water discharged by the air cylinder* and deliver it to the "cooling tower." This is the general arrangement when working on the "wet" system.

Compactness, simplicity, strength and durability are prominent features of these pumps, while the *cost*, as compared with the usual cumbersome pumping apparatus, is considerably less. But little labor is required to erect them; heavy and expensive foundations are unnecessary. The working parts being few in number and substantial in construction, the cost of maintaining these pumps in perfect working order is comparatively a trifle

SIZES AND PRICES:

Steam Cylinder. Inches.	Air Cylinder. Inches.	Water Cylinder. Inches.	Stroke. Inches.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Price.	REMARKS.
8	8	4½ or 5	12	1	1¼		
10	10	5 or 6	12	1¼	1½		
12	12	6 or 7	16	2	2½		
14	14	8 or 9	16	2½	3		
14	16	9 or 10	16	2½	3		
16	18	10 or 12	24	2½	3		
18	20	12 or 14	24	3½	4		
20	22	13 or 14	24	3½	4		
20	24	14 or 16	24	3½	4		

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

* A favorite way with us now is to connect the delivery nozzle of the air cylinder directly to the suction nozzle of the water cylinder by a suitable pipe, thus saving the expense and room for a hot-well tank. This pipe connection we supply at a slight additional cost.

As shown by the engraving on opposite page, the piston rod stuffing-box in the head of the air cylinder is sealed with water, thus preventing any possible leak of air through the gland to deteriorate the vacuum when pump is in operation.

The valve seats, valve bolts, linings, and piston rods of both water and air cylinders are of gun-metal composition, substantially made.

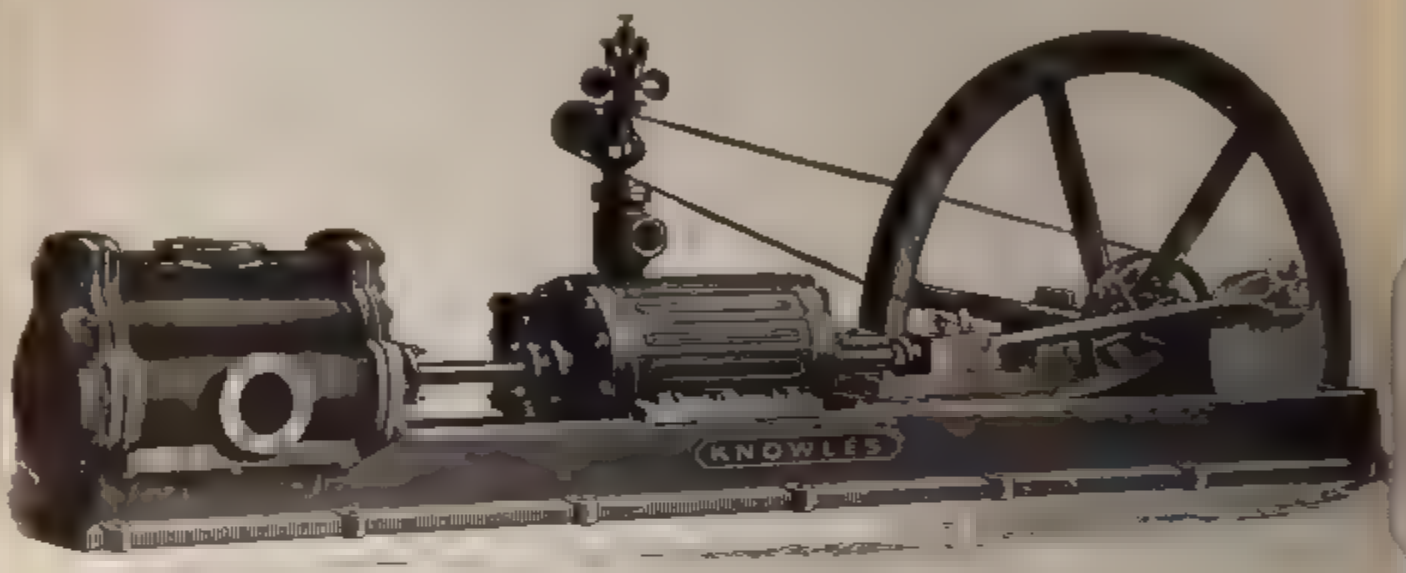
COMBINED VACUUM AND WATER PUMPS of the Crank and Fly-Wheel Pattern, see page 71.

COMBINED INJECTION AND REFRIGERATOR PUMPS and other Sugar-House Pumps, see pages 72 and 73.

KNOWLES PATENT

FLY-WHEEL VACUUM PUMPS.

SINGLE CYLINDER CRANK AND FLY-WHEEL PATTERN.



THERE are many engineers who prefer Vacuum Pumps of the single cylinder long stroke crank and fly wheel pattern, contending that although more expensive in first cost, they possess certain advantages over the direct acting and short stroke duplex fly-wheel vacuum pumps. To meet this preference, we have designed a very superior machine, as shown by the engraving above. We have a large variety of of sizes of these vacuum pumps as per table below given.

SIZES AND PRICES.

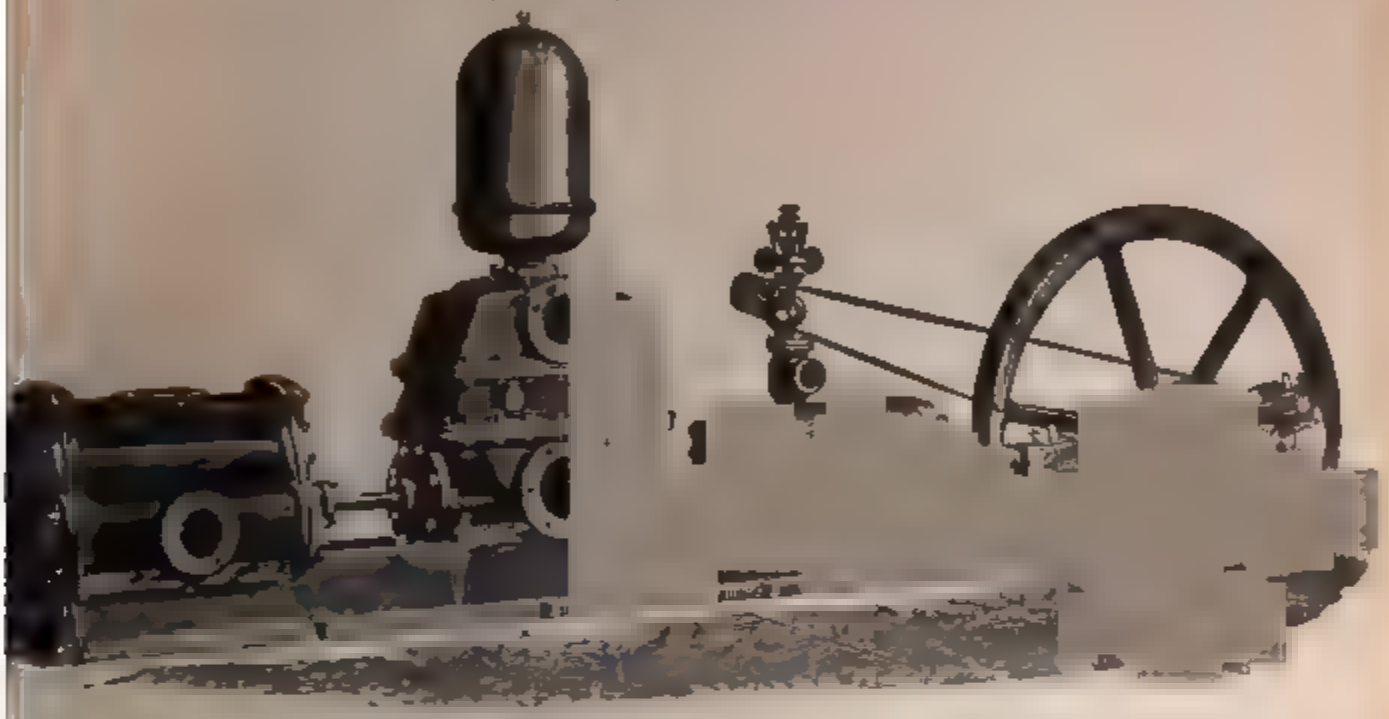
Steam Cylinder. Inches.	Air Cylinder. Inches.	Stroke. Inches.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Price.	REMARKS.
10	14	16	2½	3½		
12	16	16	3	4		
14	18	24	3½	4		
16	20	24	4	5		
18	22	24	4½	6		
18	24	24	4½	6		
20	26	24	5	7		
22	28	24	5	8		

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

The lining, valve seats, piston rod, etc., of the air cylinder, are made of composition; the piston is also made of the same material, packed with adjustable fibrous packing.

KNOWLES PATENT
COMBINED VACUUM & WATER PUMPS.

CRANK AND FLY-WHEEL PATTERN.



TO meet the demand of those who have a preference for Combined Vacuum and Water Pumps made on the Crank and Fly Wheel System, we have built special patterns for a full line of sizes, as will be seen by table below.

As shown by the engraving above, the steam, air and water cylinders are mounted on a substantial bed-plate. The steam cylinder is provided with all the latest improvements. The connecting rod, shaft, etc., are made of the best forged iron. The governor is adjustable to any speed desired. The air cylinder is of improved design. The water cylinder is built on our "double cap" pattern, having large valve area, etc.

SIZES AND PRICES.

Steam Cylinder Inches.	Air Cylinder Inches.	Water Cylinder Inches.	Stroke. inches.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Price.	REMARKS.
10	10	6	12	3½	3½		
12	12	7	16	3	4		
14	14	8	16	3½	4		
16	16	9	16	4	5		
18	18	12	24	4½	6		
20	20	13	24	4½	6		
22	22	14	24	5	7		
24	24	16	24	5	8		

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

Both air and water cylinders have composition linings, pistons, valve seats, etc. The piston rod is of steel or composition and extends from the steam piston to the air piston, passing through the water cylinder. Vertical Combined Vacuum and Water Pumps, built on the "Working Beam" pattern, of improved design, also furnished. Full particulars on application.

KNOWLES PATENT

...BINE ...JECTION & REFRIGERATOR PUMPS.

For Plantation Sugar Houses, etc.

THIS compact and economical arrangement or combination of two water cylinders, driven by a Knowles direct-acting steam cylinder, is especially adapted to the condensing apparatus of single vacuum pans, "double" and "triple effects," where the "dry" system is used—as in Cuba, San Domingo, and other tropical countries where the water supply for condensing purposes is very limited.

The cold water cylinder elevates the injection water to the tank * that supplies the condenser, while the hot water cylinder takes the warm water (discharged by the vacuum pump) from the "hot well" tank and pumps it to the "refrigerator," or cooling-tower.

The hot water cylinder being larger than the cold water cylinder, it is impossible to overflow or flood the "hot well" tank. Besides this desirable feature, the advantage and economy of having both water cylinders directly connected to and worked by one steam cylinder is one of importance.

Both water cylinders are arranged with gun-metal composition linings, valve seats, valve bolts, piston rods, ... The valve areas are large and the water passages roomy and direct.

The cold water cylinder has the best quality of vulcanized rubber valves and gun-metal composition piston, the latter packed with fibrous packing or leather cups, as preferred.

The hot water cylinder has hard rubber or brass valves and gun-metal composition piston, the latter packed with fibrous packing or composition rings, as preferred.

SIZES AND PRICES:

Steam Cylinder Inches.	Cold Water Cylinder Inches.	Hot Water Cylinder Inches.	Stroke Inches.	Steam Pipe Inches.	Exhaust Pipe Inches.	Suction Pipes. Inches.	Delivery of Pipes. Inches.	Price.
12	8	9	12	2	2½	6	6	
14	9	10	12	2	2½	6	6	
14	10	12	12	2	2½	8	6	
16	10	12	12	2½	3	8	6	
16	10	12	16	2½	3	8	6	
18	12	14	16	2½	3			
18	12	14	24	3½	4			
20	12	14	24	3½	4			
20	14	16	24	3½	4			

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

* When the water tank is provided with a float, pulley and cord, properly arranged so as to operate the throttle valve on the steam pipe, the Combined Injection and Refrigerator Pump is made to work AUTOMATICALLY. By this simple arrangement the supply of steam to the steam cylinder is regulated and the speed of the pump perfectly controlled. The injection water, as it is taken out of the supply tank by the condenser, immediately lowers the float, which in turn opens the steam throttle and speeds up the pump. On the rising of the float the pump decreases its speed, and when the tank is full the pump stops altogether.

Pumps for "INJECTION" or "REFRIGERATOR" service (not combined as above), see page 9, price-list of TANK OR LIGHT SERVICE PUMPS.

VACUUM PUMPS, see pages 64, 65, 66 67 and 70.

COMBINED VACUUM AND WATER PUMPS, see pages 68, 69, and 71.

KNOWLES PATENT

COMBINED "SWEET WATER" & SYRUP PUMPS.

For "Double Effects" and "Triple Effects," etc.

THE pumping plant of a plantation sugar house is considerably simplified by the use of Knowles Improved Combined "Sweet Water" and Syrup Pump. This machine combines efficiency and simplicity with economy in the use of steam.

The steam cylinder is placed between the "sweet water" pump and the syrup pump, to both of which it is directly connected—the general arrangement being similar to the engraving on page 68.

The "sweet water" pump is intended to drain the heating coils of the second and third vacuum pans of a "triple effect," or the coils of the second vacuum pan of a "double effect."

The syrup pump takes the boiling syrup from the last "effect" pan and pumps it to the "strike" pan.

SIZES AND PRICES:

Steam Cylinder. Inches.	SweetWater Cylinder. Inches.	Juice Cylinder. Inches.	Stroke. Inches.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Price.	REMARKS.
6	6	4	7	¾	1		
8	8	5	12	1	1¼		
10	10	6	12	1¼	1½		
12	12	7	12	2	2½		

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

Both pumps have gun-metal composition cylinder linings, valves, valve seats, pistons, piston rods

SUGAR-HOUSE PUMPS.

The Improved Knowles Pumps, as arranged for sugar-house work, whether for refinery or plantation, are without exception, the most efficient and durable. They will pump cane-juice ("Gurapo"), syrup ("Meladura") and molasses, etc., with the greatest freedom, having pump valves especially designed for the purpose.

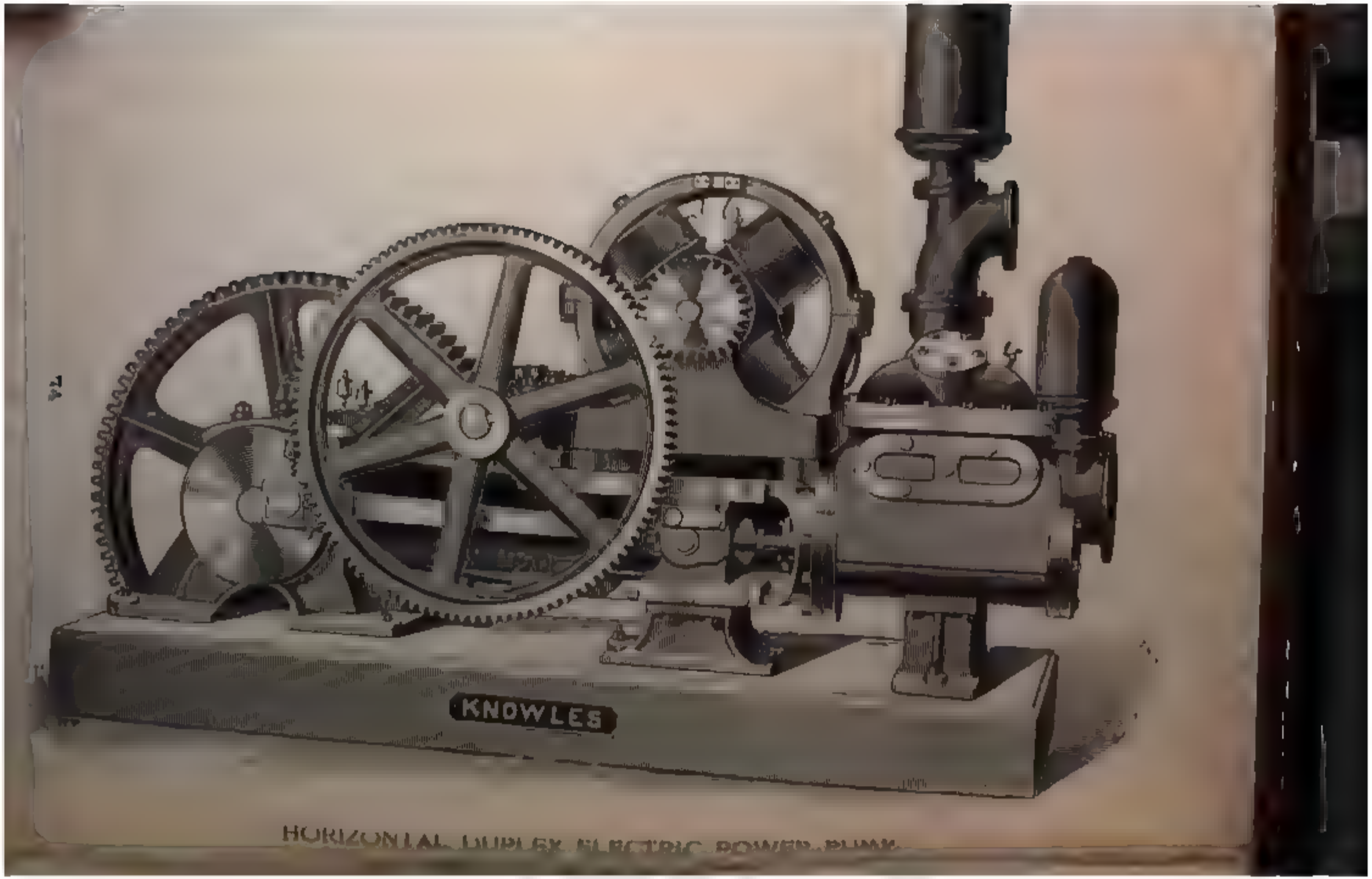
SIZES, CAPACITIES AND PRICES:

Steam Cylinder. Inches.	Pump Cylinder. Inches.	Stroke. Inches.	Gallons per Stroke.	Capacity per Minute at Ordinary Speed.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipe. Inches.	Delivery Pipe. Inches.	Price.
4	4	5	.27	125 Strokes, 33 gals.	½	¾	2	1½	
5	4	7	.39	125 " 49 "	¾	1	2½	2	
5½	5½	7	.72	125 " 90 "	¾	1	3	2½	
6	6	12	1.47	100 " 147 "	¾	1	4	4	
7½	7	10	1.66	100 " 166 "	1	1¼	4	4	
8	6	12	1.47	100 " 147 "	1	1¼	4	4	
8	7	12	2.00	100 " 200 "	1	1¼	5	5	
8	8	12	2.61	100 " 261 "	1	1¼	5	5	

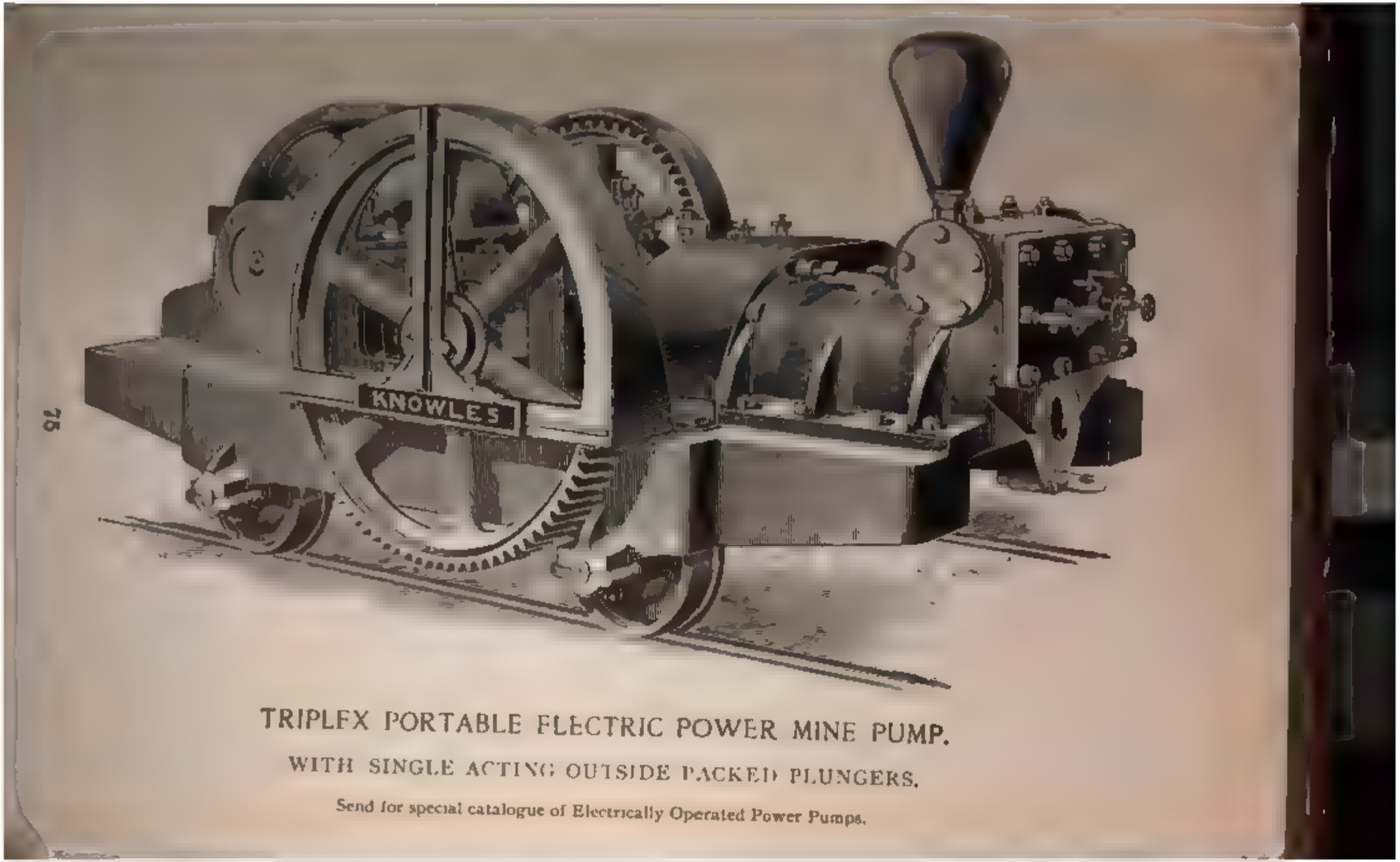
LARGER SIZES TO ORDER.

The linings, valves, valve seats, pistons, piston rods, etc., of the pump cylinders are made of the best gun-metal composition.

When pumps are ordered to have pump cylinders made entirely of *gun-metal composition*, we use special light patterns for this purpose, charging only for the additional cost of composition metal.



HORIZONTAL DUPLEX ELECTRIC POWER PUMP.



TRIPLEX PORTABLE ELECTRIC POWER MINE PUMP.

WITH SINGLE ACTING OUTSIDE PACKED PLUNGERS.

Send for special catalogue of Electrically Operated Power Pumps.

KNOWLES PATENT LOW-PRESSURE PUMP.

With Hand Power Attachment

KNOWLES PATENT
LOW-PRESSURE PUMPS.

For Public and Private Buildings, etc.

THE Knowles Low-Pressure Pumps are constructed similar to our regular boiler-feed pumps—the only difference being that in the former the steam cylinders are much larger in proportion to the water cylinders, thereby enabling them to be operated by steam pressure ranging as low as three to ten pounds per square inch.

These pumps are principally used for elevating water in buildings where the low-pressure system of heating apparatus is in operation. They are perfectly *positive* in operation under any pressure—no matter how low. They work *without noise*, are easily managed and not liable to get out of order.

SIZES, CAPACITIES AND PRICES:

Steam Cylinder. Inches.	Water Cylinder. Inches.	Stroke. Inches.	Gallons per Stroke.	* Capacity per Minute at Ordinary Speed.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipe. Inches.	Discharge Pipe. Inches.	Price.
6	2	6	.08	125 Strokes, 11 gals.	¾	1	1¼	1	
7½	2½	7	.14	125 " 17½ "	1	1¼	2	1¼	
8	3	7	.21	125 " 26 "	1	1¼	2	1½	
10	3½	10	.40	125 " 50 "	1¼	1½	As desired.	As desired.	
10	3½	12	.50	100 " 50 "	1¼	1½			
12	4	12	.64	100 " 64 "	2	2½			
12	4½	12	.82	100 " 82 "	2	2½			
14	5	12	1.02	100 " 102 "	2½	3			

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS.

* Twice the above capacities can be had in emergencies; but for continuous work we advise about half the speeds stated.

Every pump has suction and delivery openings on both sides; consequently, connections can be made on either side desired. When ordering a pump, it is necessary to give height water is to be pumped, also the *maximum* quantity required per hour; also state steam pressure carried.

The PATENT HAND-POWER ATTACHMENT, as shown in engraving opposite, is furnished on the first three sizes. It is very convenient for hand pumping when steam is down.

☞ We also furnish these pumps arranged with Independent Low-Pressure Boilers, especially designed for domestic service. Prices, etc., on application.

VERTICAL FEED PUMPS.

For Locomotives, Steam Launches, etc.

FOR feeding boilers of locomotives, steam launches, steam yachts, and for other places where floor space is very limited, these Improved Vertical Pumps are especially adapted. They are double-acting, and, being very compact, take but little room. They are efficient, reliable and durable. Being *positive* and continuous in their action, they deliver a steady stream of water to the boilers at any speed desired.

For locomotives they can be placed in any convenient position—under the foot boards, if preferred. For steam launches and steam yachts they are usually bolted to the *side* of the boilers.

SIZES, CAPACITIES AND PRICES:

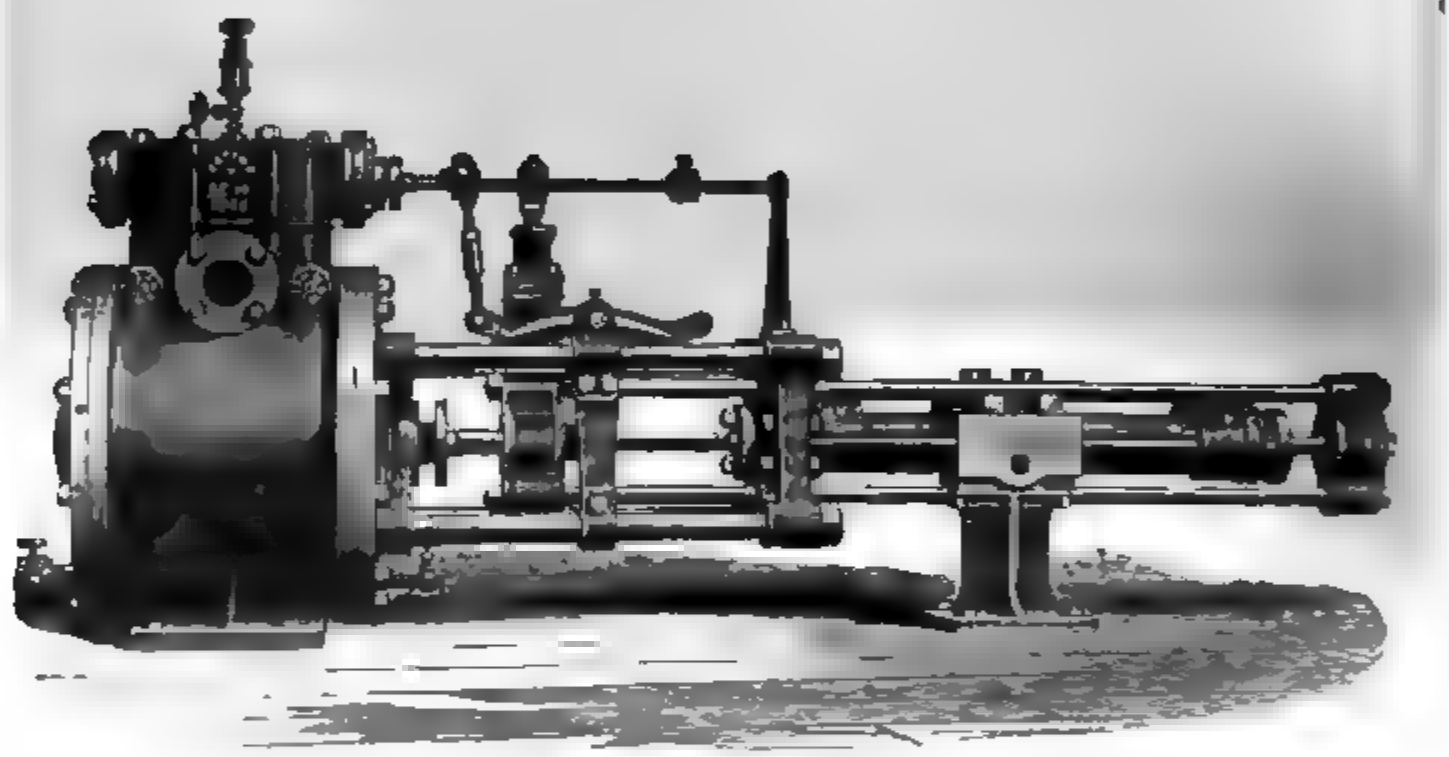
No.	Steam Cylinder. Inches.	Water Cylinder. Inches.	Stroke. Inches.	Gallons per Stroke.	* Capacity per Minute at Ordinary Speed.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipe. Inches.	Delivery Pipe. Inches.	Price.
0	3¼	2	4	.05	6 Gallons.	½	¾	1¼	1	
1	3½	2¼	4	.07	10½ "	½	¾	1¼	1	
2	4	2½	5	.15	16 "	½	¾	1¼	1	

LARGER SIZES TO ORDER.

* Twice the above capacities can be had in emergencies; but for continuous work, such as boiler-feeding, about half the capacities stated is fair work for regular duty.

These pumps provided with our hand-power attachment without extra charge. By this PATENT ATTACHMENT the pump can be worked by hand, when steam is down, for filling boilers after "blowing off," washing decks, etc.

Patterns also for *vertical* TANK OR LIGHT SERVICE PUMPS, MARINE PUMPS, etc.



KNOWLES PATENT HYDRAULIC PRESSURE PUMP.

SINGLE CYLINDER PATTERN,

With Double-Acting Outside Connected Plungers.

(See description and price list on pages 80 and 81.)

KNOWLES PATENT HYDRAULIC PRESSURE PUMP.

DUPLEX PATTERN,

With Double-acting Outside Connected Plungers.

(See description and price list on page 81.)

KNOWLES PATENT

HY. ULIC PRESSURE PUMPS.

(AS ILLUSTRATED ON PAGE 78.)

For Steel Works, Hat Factories, Pipe Works, Paper Mills, Cotton and other Presses.

THE superior advantages of the Knowles Direct-acting Hydraulic Pressure Pumps for working hydraulic presses, etc., in lieu of crank pumps, with their complication of gears, fly-wheels, belts, pulleys, etc., has been fully demonstrated, especially among the owners of the large Southern cotton presses and oil mills. These improved pumps are also especially adapted for operating hydraulic cranes, testing machines, hydraulic riveting and punching machines, and hydraulic presses of all kinds. They are built from new and improved designs, combining great strength and power with simplicity and durability. We have patterns for every possible size or combination of steam cylinders to pump plungers, so that we can promptly fill orders for pumps to operate against any pressure desired—say from 200 to 12,000 lbs. per square inch.

These hydraulic pumps are *double-acting*, and will consequently deliver a steady, continuous flow of water. They are absolutely *positive* in operation, and can be run at the slowest speed possible. If desired, they can be operated automatically to run at varying speeds, according to the demands of the work to be performed.

On some of the largest hydraulic presses in this country we have these pumps in operation, where they are arranged in a series of two or more powers, and connected up to run *automatically*. The lowest power moves the ram of the press the greater distance against the minimum pressure, the next in the series moving the ram a less distance against the constantly increasing pressure, and so on, each in turn starting at the instant the preceding one attains its maximum pressure. By this arrangement a pumping plant of less *first* cost can be used and a saving of fuel secured.

SIZES AND PRICES:

Steam Cylinder Inches.	Plungers Inches.	Stroke. Inches.	Gallons per Stroke.	*Pressure Lbs.	Price.	Steam Cylinder Inches.	Plungers. Inches.	Stroke. Inches.	Gallons per Stroke.	*Pressure Lbs.	Price.
4½	½ to 1	6				10	1	12	.04	5500	
5⅛	½	7	.006	7000		10	1⅛	12	.051	4700	
5⅛	¾	7	013	3200		10	1¼	12	.063	3500	
5½	1	7	024	1800		10	1½	12	.09	2500	
6	½	7	006	8000		10	1¾	12	.12	1900	
6	¾	7	013	3500		10	2	12	.16	1500	
6	1	7	024	2000		10	2⅛	12	.20	1200	
8	⅝	10	013	9000		10	2½	12	.25	900	
8	¾	10	020	6800		10	2¾	12	.31	700	
8	1	10	034	3500		10	3	12	.37	600	
8	1⅛	10	043	300		12	1	12	.04	8600	
8	1¼	10	053	2300		12	1¼	12	063	5000	
8	1½	10	076	1500		12	1½	12	.09	3000	
8	1¾	10	10	1050		12	1¾	12	.12	2500	
8	2	10	13	900		12	2	12	.16	2000	
8	⅝	12	015	9000		12	2⅛	12	.20	1500	
8	¾	12	023	6800		12	2½	12	.25	1300	
8	1	12	04	3500		12	2¾	12	.31	1100	
8	1⅛	12	051	3000		12	3	12	.37	900	
8	1¼	12	063	2300		14	1	12	.04	10000	
8	1½	12	09	1500		14	1¼	12	.063	7000	
8	1¾	12	12	1050		14	1½	12	.09	5000	
8	2	12	16	900		14	1¾	12	12	3500	
8	2⅛	12	20	700		14	2	12	16	2700	
8	2½	12	25	550		14	2⅛	12	.20	2000	
10	¾	12	023	8600		14	2½	12	.25	1700	

(CONTINUED ON NEXT PAGE.)

KNOWLES PATENT

DRAULIC PRESSURE PUMPS—CONTINUED

Plungers. Inches.	Stroke. Inches.	Gallons per Stroke.	*Pressure Lbs.	Price.	Steam Cylinder. Inches.	Plungers. Inches.	Stroke. Inches.	Gallons per Stroke.	*Pressure Lbs.	Price.
2¼	12	.31	1550		18	2¾	24	.62	2500	
2	12	.37	1300		18	3	24	.74	2100	
1¾	12	.06	9800		18	3½	24	.90	1500	
1½	12	.09	6800		18	4	24	1.30	1200	
1¼	12	.12	5000		20	2	18	.24	6400	
1	12	.16	3800		20	2¼	18	.30	4700	
2¼	12	.20	3000		20	2½	18	.37	3800	
2½	12	.25	2400		20	2¾	18	.46	3100	
2¾	12	.31	2000		20	3	18	.55	2600	
3	12	.37	1700		20	3½	18	.68	1959	
1¾	18	.095	9800		20	4	18	.98	1500	
1½	18	.135	6800		20	2	24	.32	6000	
1¼	18	18	5000		20	2¼	24	.40	4700	
2	18	.24	3800		20	2½	24	.50	3800	
2¼	18	.30	3000		20	2¾	24	.62	3100	
2½	18	.37	2400		20	3	24	.74	2600	
2¾	18	.46	2000		20	3½	24	.90	1900	
3	18	.55	1700		20	4	24	1.30	1500	
3½	18	.68	1250		24	2	18	.24	8600	
4	18	.98	950		24	2¼	18	.30	6800	
2	24	.32	3800		24	2½	18	.37	5500	
2¼	24	.40	3000		24	2¾	18	.46	4500	
2½	24	.50	2400		24	3	18	.55	3800	
2¾	24	.62	2000		24	3½	18	.68	2800	
3	24	.74	1700		24	4	18	.98	2100	
3½	24	.90	1250		24	4½	18	1.23	1700	
4	24	1.30	950		24	5	18	1.50	1300	
2	18	.24	4800		24	2	24	.32	8600	
2¼	[illegible]	.30	3800		24	2¼	24	.40	6800	
2½	18	.37	3100		24	2½	24	.50	5500	
2¾	18	.46	2500		24	2¾	24	.62	4500	
3	18	.55	2200		24	3	24	.74	3800	
3½	18	.68	1500		24	3½	24	.90	2800	
4	18	.98	1200		24	4	24	1.30	2100	
2	24	.32	4800		24	4½	24	1.65	1700	
2¼	24	.40	38.0		24	5	24	2.00	1300	
2½	24	.50	3100							

ALSO PATTERNS FOR LARGER SIZES AND OTHER COMBINATIONS.

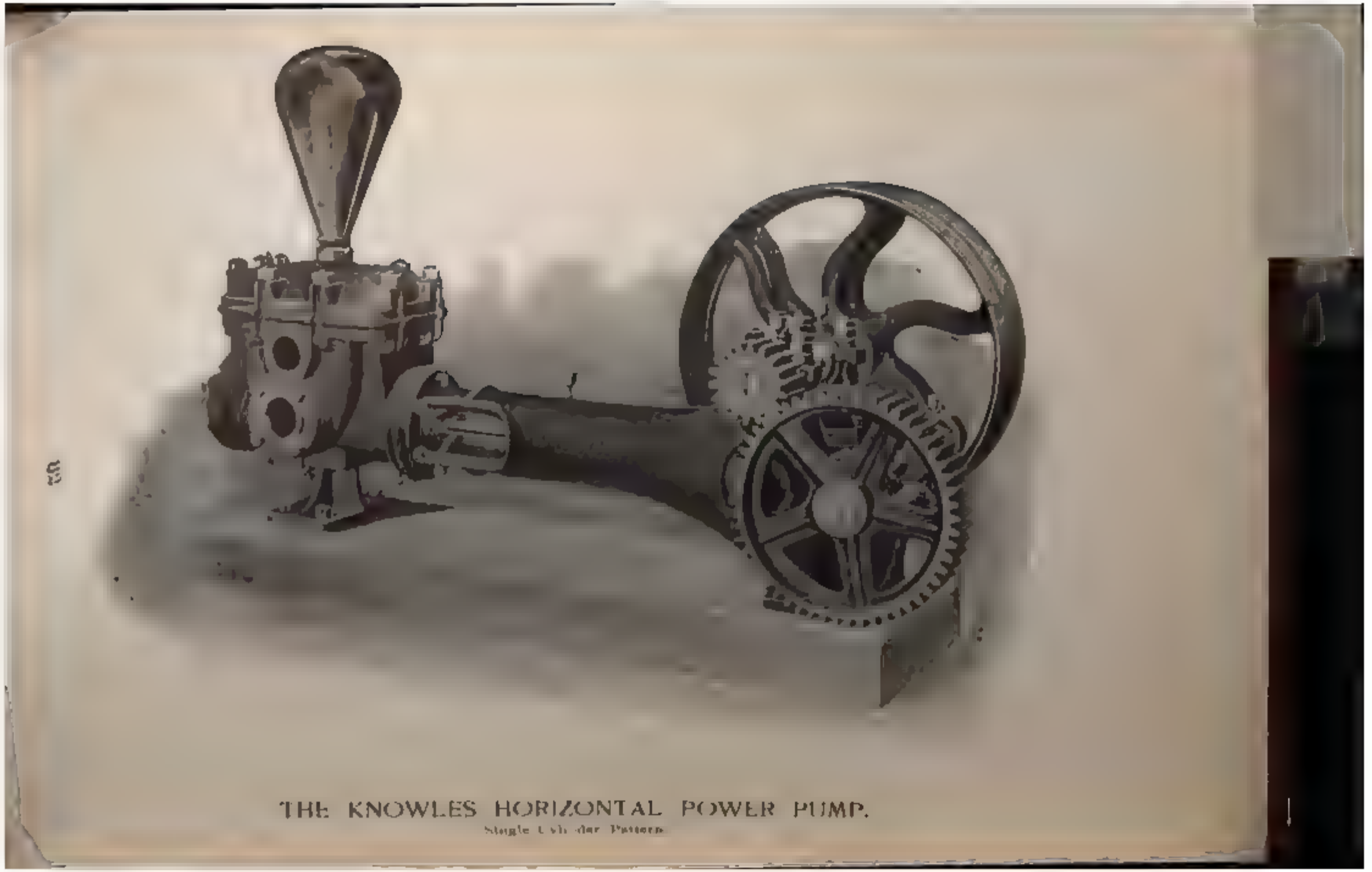
to "pressure" columns give approximately the hydraulic pressure in pounds per square inch which can be exerted under plungers with a steam pressure of about 80 pounds in the steam cylinder, the pumps then standing balanced. The steam pressure will give proportionately greater hydraulic pressure.

OMATIC PRESSURE REGULATORS, complete, with balanced steam throttles furnished when ordered at additional cost.

NECTIONS.—Suction and discharge connections arranged according to requirements of each case. The ed exhaust connections are the same as given for steam cylinders of pumps in table on page 5.

UPLEX HYDRAULIC PRESSURE PUMPS.

shown by Illustration on page 79, we also make our improved Hydraulic Pressure Pumps on the duplex tem. They are very steady in action, and can be operated automatically, same as the above. We have d improved designs and patterns for all sizes. Prices and further particulars on application.



THE KNOWLES HORIZONTAL POWER PUMP.

Single Cylinder Pattern.

THE KNOWLES

HORIZONTAL POWER PUMP.

SINGLE CYLINDER PATTERN.

THE cut on opposite page shows one of our improved power pumps, Double Acting Single Cylinder pattern, fitted with gears. We also make the same pump designed to drive directly by belt, without intermediate gearing. This style of pump has suction and discharge valves above the cylinder barrel, and is designed to stand a water pressure of 100 pounds per square inch. Adjustments are provided, so that wear can be taken up in all bearings, slides, and other parts subject to wear. Every part is carefully proportioned, and material and workmanship are of the best. All gears and pinions have machine cut teeth.

The best gun metal composition is used in the linings, valve seats, and pistons, the latter being suitably packed for hot or cold water or other liquids.

Heavy balance wheels are provided for all sizes.

The capacities in the table below are figured at the moderate speed of 80 feet piston travel per minute; this can be increased if desired.

We have patterns also for power pumps arranged with *inside or outside plungers*, suitable for gritty or bad water.

When sending inquiries or orders, always state the pressure against which pump will have to work.

SIZES AND CAPACITIES.

Diameter of Piston.	Stroke.	Gallons per Revolution.	Gallons per Minute.	Suction.	Discharge.	Code Word.	Diameter of Piston.	Stroke.	Gallons per Revolution.	Gallons per Minute.	Suction.	Discharge	Code Word.
3	6	.36	29	2	1½	Elusion	9	12	6.60	264	6	6	Embalmer
3¼	6	.43	35	2	1½	Elusive	10	12	8.14	326	6	6	Embank
3¾	6	.57	46	2	1½	Elusory	10	16	10.86	326	6	6	Embargo
4	6	.66	52	2½	2	Eluted	10	24	16.32	326	6	6	Embase
3¼	10	.72	35	2½	2	Eluting	12	12	11.74	470	8	6	Embattle
3¾	10	.96	46	2½	2	Eluxate	12	16	15.66	470	8	6	Embay
4⅛	10	1.11	54	3	2½	Elvan	12	24	23.48	470	8	6	Ember
4½	10	1.38	65	3	2½	Elvish	14	16	21.32	640	10	8	Embezzle
5	10	1.70	82	3	2½	Elysian	14	24	32.00	640	10	8	Emblaze
6	12	2.93	117	4	4	Emaciate	16	16	27.84	836	12	10	Emblem
7	12	4.00	160	5	5	Emanate	16	24	41.76	836	12	10	Embody
8	12	5.22	209	5	5	Embale							

ALSO PATTERNS FOR LARGER SIZES OR COMBINATIONS.

KNOWLES PATENT POWER PUMP.

DUPLEX PATTERN.

THE KNOWLES HORIZONTAL

DUPLEX POWER PUMP.

PISTON, OR INSIDE PLUNGER PATTERN. GIRDER 97 FRAME.

THE Duplex form of Power Pumps we recommend for water works service, for supplying hydraulic elevators and for such other places as require a very steady or heavy pressure with uniform action. These pumps can be geared directly to the jack shaft of turbine water wheels, or can be driven by belt or gear connection from line shafting run by water or steam power. For hydraulic elevator work they are often driven by gas engines.

These pumps are carefully designed and built with great thoroughness. Each water cylinder is double-acting, and is arranged with lining and valve-seats of composition. The crank-shafts, connecting rods, cross-heads, gears, etc., are well proportioned and made of the very best materials. All bearings, slides, etc., are arranged for taking up wear. The cranks are set at right angles; as shown by the engraving on opposite page, these pumps are arranged with heavy band wheels.

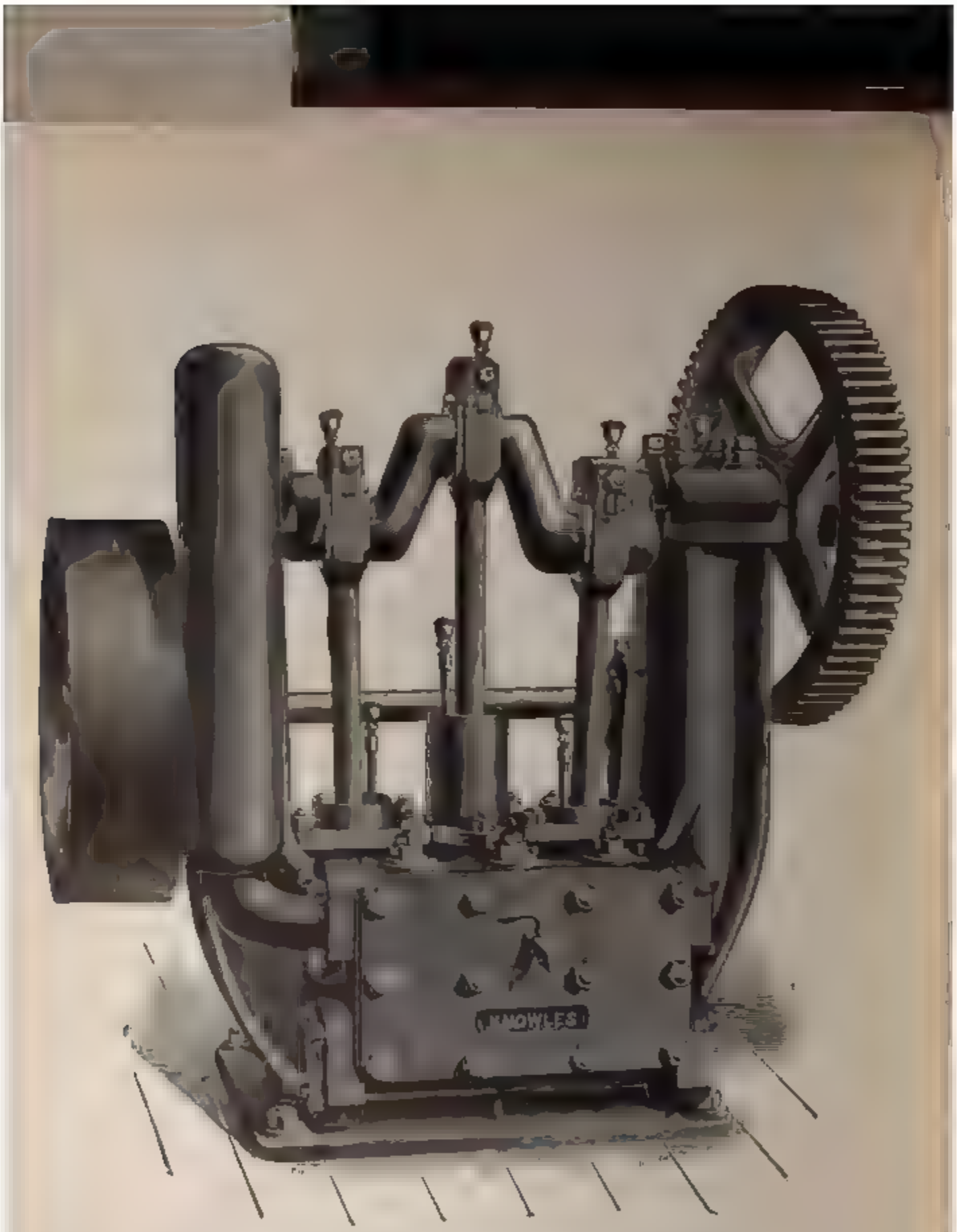
All gears have machine-cut teeth. All sizes in the following list can be made for water pressures as high as 130 pounds per square inch. We have also many patterns for pumps of this type designed for lighter, and for heavier pressures than the above. As the cost of a power pump depends largely upon the pressure it must be suited for, always in sending inquiries or orders state the water pressure pump must develop, as well as the capacity required.

SIZES AND CAPACITIES.

Diameter of Cylinders	Stroke.	Gallons per Revolution (Both Cylinders).	Gallons per Minute.	Suction.	Discharge.	Code Word	
						Piston Pattern	Inside Plunger Pattern.
3¾	6	1.14	92	3	2	Emphasis	Emulous
4⅛	6	1.39	111	3	2	Emphatic	Emulsion
5½	6	2.47	198	5	4	Empight	Emulsive
5	12	4.08	163	5	4	Empiric	Enable
6	12	5.88	235	5	4	Emporium	Enabling
7	12	8.00	320	6	5	Empower	Enact
8	12	10.44	418	8	6	Empress	Enacting
9	12	13.20	528	10	8	Emprise	Enactive
10	12	16.28	651	10	8	Emption	Enactor
10	18	24.42	651	12	10	Empurple	Enambush
12	12	23.48	940	12	10	Empuse	Enamor
12	18	35.20	940	12	10	Empyema	Enarmed
12	24	46.97	940	14	12	Empyreal	Enate
14	18	48.00	1280	14	12	Emulate	Enaunter
14	24	64.00	1280	14	12	Emule	Encamp
16	18	62.66	1670	16	14	Emulge	Encamped
16	24	83.55	1670	16	14	Emulgent	Encanker

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS

The capacities are figured at moderate speed, namely, 80 feet piston travel per minute. This speed can be increased if desired.



VERTICAL TRIPLEX BELTED POWER PUMP.

Size, 4x6 Style B.

We issue a special catalogue on triplex power pumps, both belt driven and electric driven, which we will send on application.

[redacted]

KNOWLES VERTICAL TRIPLEX
BELTED POWER PUMP.

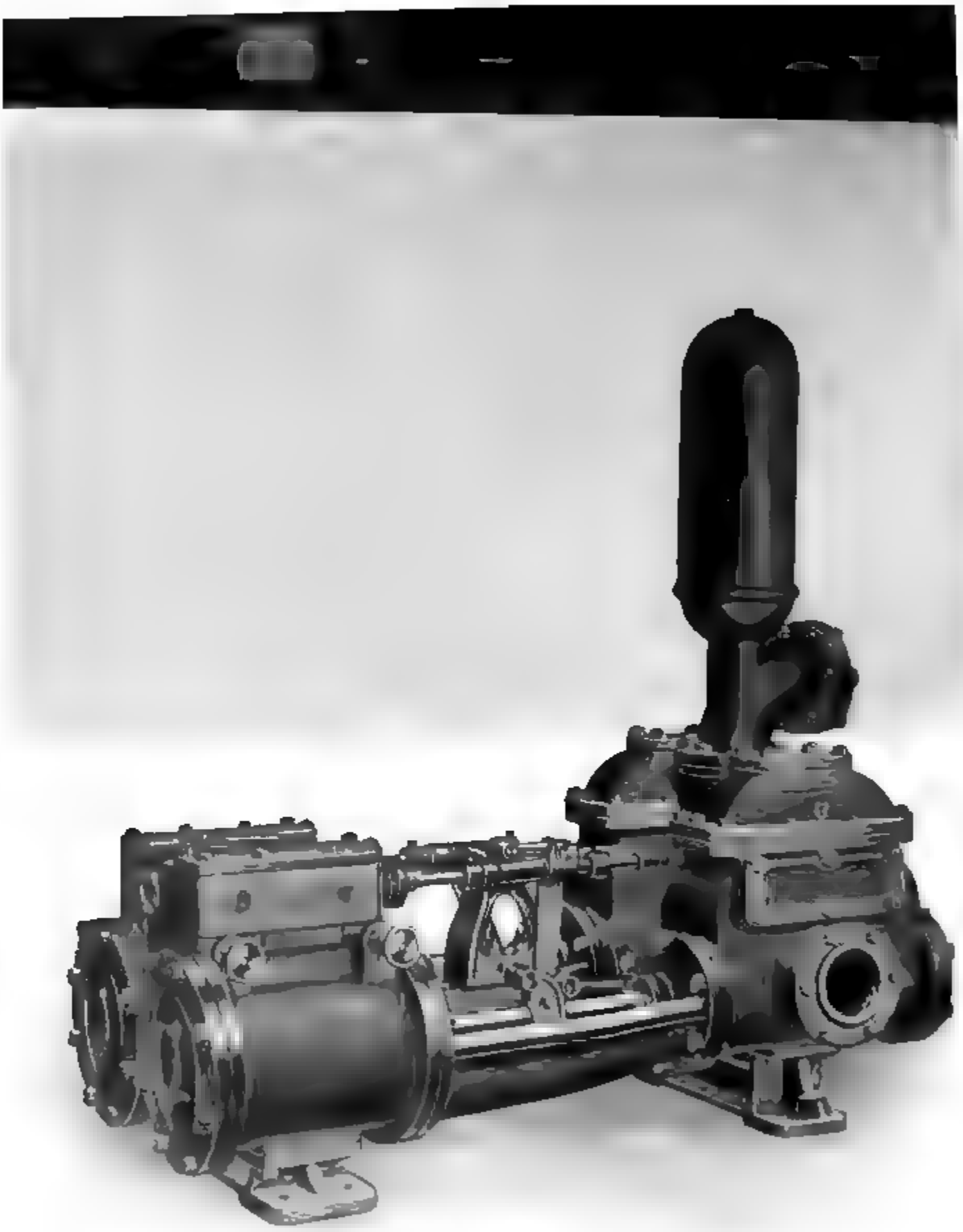
SIZES, CAPACITIES, AND DIMENSIONS.—FOR 300 FEET LIFT.

Diameter of Plungers	Stroke	Revolutions per Minute.	Gallons per Revolution.	Gallons per Minute.	Suction.	Discharge.	Style.	Pulleys, Tight and Loose. Diameter.	Pulleys, Tight and Loose. Face	Ratio of Gears.	Dimensions over all. Length.	Dimensions over all. Width.	Dimensions over all. Height.	Code Word.
1¼	2	60	.0319	1 9	⅜	¼	D	12	1¾	5 to 1				Dabble
1¼	2½	60	.0780	4.6	1	1	D	12	1¾	5 " 1				Dabster
2	3	90	.1224	6.1	1¼	1¼	D	12	2½	5 " 1				Dado
2¼	3½	50	.1912	9.5	1½	1½	D	12	2½	5 " 1				Daffodil
2½	4	50	.2500	12 5	1¼	1¼	H	15	3	5 " 1				Dagger
3	4	45	.3673	16.5	1½	1½	B	15	3	5 " 1				Dainty
4	4	45	.6528	29.3	2	2	B	20	3	5 " 1				Dairy
4	6	40	.9787	39 1	2	2	B	20	3	5 " 1				Dahlia
5	6	40	1.530	61 2	3	3	B	26	4	5 " 1				Dally
5	8	40	2.040	81 6	3	3	B	30	5	5 " 1				Damask
6½	8	40	3.448	137	4	4	B	30	6	5 " 1				Damper
7	8	40	5.222	208	5	4	B	36	6	5 " 1				Damsel
8	10	40	6.525	261	5	4	B	42	6	5 " 1				Dander
8	12	40	7.833	314	5	4	A	42	6	6 " 1				Dapper
9	10	40	8.262	330	6	5	A	42	6	6 " 1				Darkly
9	12	40	9.915	397	6	5	A	42	8	6 " 1				Darling
10	12	40	12.243	490	8	7	A	42	8	6 " 1				Dastard
								Pulley						
11	12	40	14.811	592	8	7	A	42	10	6 " 1				Dauber
12	12	40	17.628	705	10	8	A	48	10	6 " 1				Daunted
13	12	40	20.685	827	10	8	A	48	12	6 " 1				Dazzle

SIZES, CAPACITIES, AND DIMENSIONS.—FOR 100 FEET LIFT.

Diameter of Plungers.	Stroke	Revolutions per Minute	Gallons per Revolution	Gallons per Minute.	Suction.	Discharge.	Style	Pulleys, Tight and Loose. Diameter	Pulleys, Tight and Loose. Face	Ratio of Gears	Dimensions over all. Length.	Dimensions over all. Width.	Dimensions over all. Height.	Code Word.
4	4	45	.6528	29	2	2	E	20	3	5 to 1				Factive
4	6	40	.9787	39	2	2	E	20	3	4 " 1				Factorage
5	6	40	1.530	61	3	3	E	20	4	4 " 1				Factotum
5	8	40	2.040	81	3	3	E	20	4	4 " 1				Factual
6½	8	40	3.448	137	4	4	E	26	5	4 " 1				Facture
7	8	40	3.998	159	5	4	E	30	5	4¼ to 1				Faculty
8	8	40	5.222	208	5	4	E	30	6	5 to 1				Facund
8	10	40	6.525	261	5	4	E	36	6	5 " 1				Faddle
8	12	40	7.833	314	5	4	E	36	6	5 " 1				Fadeless
8	10	40	8.262	330	6		F	30	5	5 " 1				Fairly
9	12	40	9.915	397	6	5	F	30	5	5 " 1				Fairness
10	12	40	12.243	490	8	7	F	30	6	5 " 1				Fairy
11	12	40	14.811	592	8	7	F	30	6	4.85 to 1				Fairylike
12	12	40	17.628	705	10	8	F	42	8	5 to 1				Faith
13	12	40	20.685	827	10	8	F	42	8	5 " 1				Faithful

For dimensions and further particulars see special catalogue of "Electric and Power Pumps."



KNOWLES IMPROVED DUPLEX PUMP.

"STANDARD" (Long Stroke) PISTON PATTERN.

KNOWLES IMPROVED

DUPLEX STEAM PUMPS.

"STANDARD" (Long Stroke) PISTON PATTERN

For Feeding Boilers, Etc.

To meet a preference occasionally expressed for a well-made inexpensive duplex pump, to work against moderate pressure, with clear water, such as operating hydraulic elevators, pumping into the tanks of buildings, feeding boilers, etc., we have built a complete set of patterns embodying many decided improvements upon the duplex pumps commonly found in the market.

In the Knowles Improved Duplex Pumps plain slide valves are used of the most durable form, worked by a very simple and adjustable valve motion of improved design. The water pistons and valves are adapted to the liquid to be pumped. The water cylinders are brass lined.

The weight of these pumps is from *ten* to *twenty* per cent greater than the duplex pumps of other makers, as commonly built; they also have the advantage of *longer stroke*, and as the wear of the pump depends on the number of *reversals* of motion made in a given time, their durability is proportionately increased by this feature. Another great advantage in the longer stroke is the smaller amount of steam necessary, on account of less clearance, for a given amount of piston speed.

SIZES, CAPACITIES AND PRICES:

Steam Cylinders. Inches.	Water Cylinders. Inches.	Stroke. Inches.	Gallons per Stroke each Piston	Strokes per Minute of each Piston Ordinary Speed.	Capacity of both Cylinders at Speed stated (per Minute). Gallons.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipe. Inches.	Delivery Pipe. Inches.	Floor Space required. Inches.	Price.
3	2	3	.046	75 to 200	9 to 18	⅜	½	1¼	1	36 x 12	
4½	2¾	4	.10	75 to 150	15 to 30	½	¾	2	1½	38 x 13	
5¼	3½	6	.24	75 to 150	36 to 72	¾	1¼	2½	2	52 x 20	
6	4	7	.39	75 to 125	58 to 97	1	1½	3	2½	54 x 24	
7½	4½	10	.69	60 to 120	82 to 164	1½	1½	4	3	60 x 24	
8	5	12	1.02	50 to 100	102 to 204	1½	1½	5	4	80 x 31	
8	6	12	1.47	50 to 100	147 to 294	1½	1¼	5	4	80 x 31	
10	6	12	1.47	50 to 100	147 to 294	2	2½	5	4	80 x 31	
12	7	12	2.00	50 to 100	200 to 400	2	2½	6	5	83 x 35	
12	8½	12	3.00	50 to 100	300 to 600	2	2½	6	5	83 x 37	
14	8½	12	3.00	50 to 100	300 to 600	2½	3	6	5	83 x 37	
14	10¼	12	4.50	50 to 100	450 to 900	2½	3	8	7	83 x 44	
16	10½	12	4.50	50 to 100	450 to 900	3	3	8	7	83 x 44	
16	12	12	5.87	50 to 100	587 to 1174	3	3	10	8	83 x 50	
18½	10½	12	4.50	50 to 100	450 to 900	3	3	8	7	83 x 44	
18½	12	12	5.87	50 to 100	587 to 1174	3	3	10	8	83 x 50	
18½	14	12	8.00	50 to 100	800 to 1600	3	3	12	10	83 x 57	
20	14	18	12.00	40 to 70	960 to 1680	4	6				

PUMPS FITTED WITH COMPOSITION PISTON RODS, ETC., AT A SLIGHT ADDITIONAL COST.

Light service or Tank Duplex pumps, see pages 95-A and 95-B.

KNOWLES SPECIAL DUPLEX PUMP.

Size. 6 x 4 x 5.

The Knowles Special Duplex Pump.

Pressure Pattern, for Boiler Feeding, Etc.

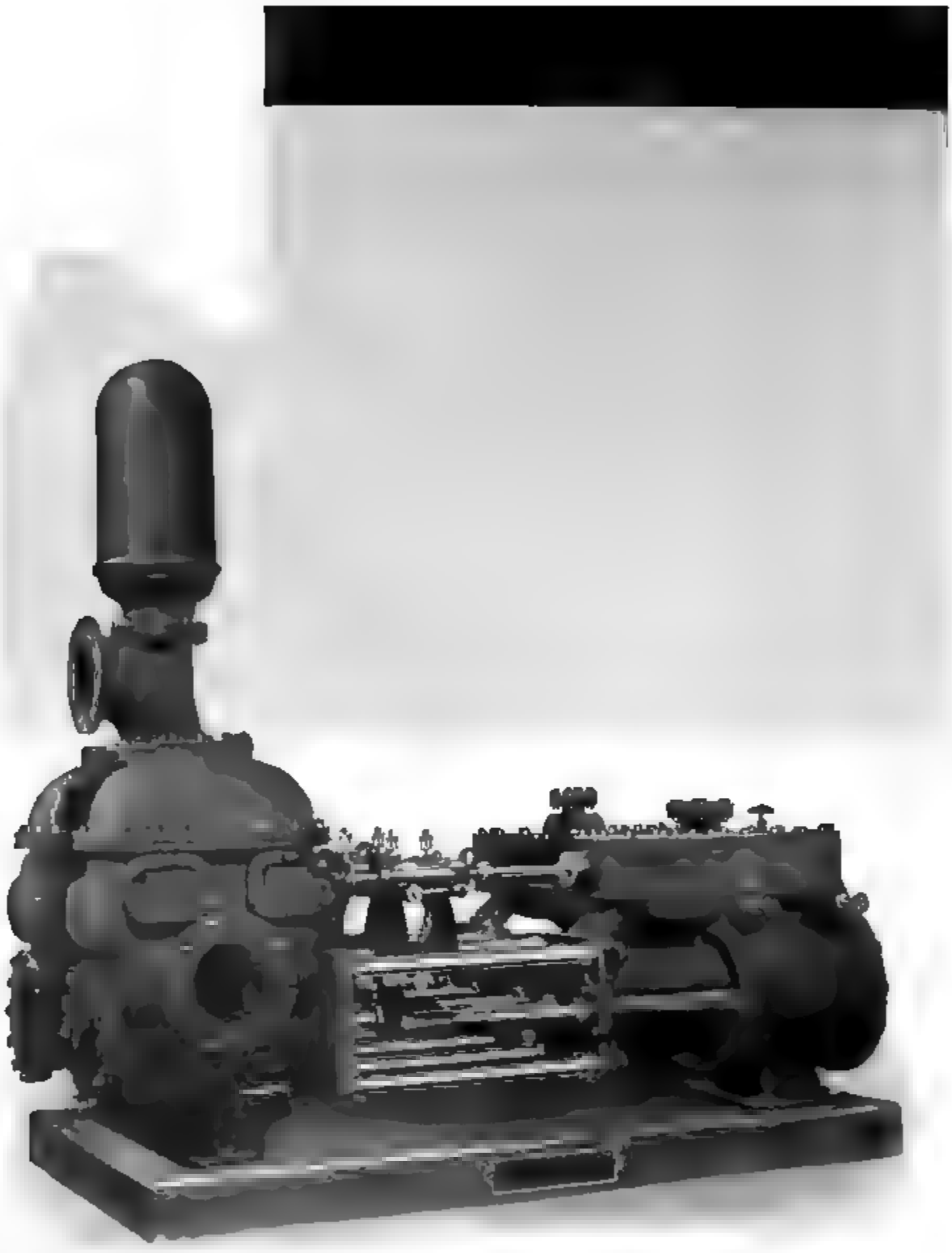
THE cut on opposite page shows one of our special pattern duplex pumps (size, 6 x 4 x 6 These pumps are provided with double acting water pistons, and are suitable f boiler feeding, fire service, or for general purposes. The water cylinders are bra lined, and the water pistons are arranged so that the packing may be readily renew when required.

Steam Cylinders.	Water Cylinders.	Stroke.	Capacity in Gallons per Stroke, each Piston.	Strokes per Minute, each Piston.	Capacity of Both Cylinders, in Gallons per Minute.	Steam Pipe.	Exhaust Pipe.	Suction Pipe.	Discharge Pipe.	Telegraphic Code Word.	
Ins.	Ins.	Ins.				Ins.	Ins	Ins.	Ins.	Regular.	Brass Fitted
2	1¼	2¾	.014	100 to 300	2 to 8	⅜	½	1	¾	Gabble	Gallisme
3	2	3	.04	100 " 250	8 " 20	⅜	½	1¼	1	Gablet	Gallitos
4½	2¼	4	.10	100 " 200	20 " 40	½	¾	2	2	Gadding	Gallivats
5¼	3½	5	.20	100 " 200	40 " 80	¾	1¼	2½	2½	Gaffer	Gallivespa
6	4	6	.33	100 " 150	66 " 100	1	1½	3	3	Gaffle	Galliwasp
7½	4½	6	.42	100 " 150	85 " 125	1¼	1½	4	3	Gaggling	Galliziano
7½	5	6	.51	100 " 150	100 " 150	1¼	1½	4	3	Gaiety	Gallizzi
7½	4½	10	.69	75 " 125	100 " 170	1¼	1½	4	3	Gaily	Gallloch
9	5¼	10	.93	75 " 125	135 " 230	1½	2	4	3	Gainable	Gallofeeis
10	6	10	1.22	75 " 125	180 " 300	1½	2	5	4	Gainful	Gallois
10	7	10	1.66	75 " 125	245 " 410	1½	2	6	5	Gainless	Gallomane
12	7	10	1.66	75 " 125	245 " 410	2½	3	6	5	Gainsay	Gallonamn
14	7	10	1.66	75 " 125	245 " 410	2½	3	6	5	Gainstand	Gallonassi
12	8½	10	2.45	75 " 125	365 " 610	2½	3	6	5	Gairish	Gallonato
14	8½	10	2.45	75 " 125	365 " 610	2½	3	6	5	Gaiter	Gallonerai
16	8½	10	2.45	75 " 125	365 " 610	2½	3	6	5	Galaxy	Galloon
18½	8½	10	2.45	75 " 125	365 " 610	3	3½	6	5	Galbulus	Gallooned
12	10¼	10	3.57	75 " 125	530 " 890	2½	3	8	7	Galiot	Gallopade
14	10¼	10	3.57	75 " 125	530 " 890	2½	3	8	7	Gallant	Gallophob
16	10½	10	3.75	75 " 125	560 " 935	2½	3	8	7	Gallate	Galloping
18½	10½	10	3.75	75 " 125	560 " 935	3	3½	8	7	Galleass	Gallorum
20	10½	10	3.75	75 " 125	560 " 935	4	5	8	7	Gallego	Gallowglas
16	12	10	4.89	75 " 125	730 " 1220	2½	3	10	8	Galleon	Gallows
18½	12	10	4.89	75 " 125	730 " 1220	3	3½	10	8	Gallery	Gallreich
20	12	10	4.89	75 " 125	730 " 1220	4	5	10	8	Galliambic	Galluche
16	14	10	6.66	75 " 125	990 " 1660	2½	3	12	10	Gallian	Gallula
18½	14	10	6.66	75 " 125	990 " 1660	3	3½	12	10	Galliard	Gallulasco
20	14	10	6.66	75 " 125	990 " 1660	4	5	12	10	Gallic	Gallulorun
18½	16	12	10.44	50 " 100	1000 " 2000	3	3½	14	12	Gallican	Gallulos
20	16	12	10.44	50 " 100	1000 " 2000	4	5	14	12	Gallicism	Gallulum

ALSO PATTERNS FOR LARGER SIZES.

A slight additional charge is made when pumps are fitted with brass pistons a brass piston rods.

To designate the sizes give the diameter of steam and water cylinders and length stroke, or use code word.



KNOWLES IMPROVED COMPOUND DUPLEX STEAM PUMP.

"Standard" (Long Stroke) Piston Pattern.

Size, 12 & 18 x 14 x 18

(Non-condensing.)

KNOWLES IMPROVED

COMPOUND DUPLEX STEAM PUMPS.

"STANDARD" (Long Stroke) PISTON PATTERN.

THE compound arrangement of steam cylinders for our Improved Duplex Pumps is for the purpose of using steam expansively—the same as in a regular cut-off steam engine—thereby saving about one-third of the steam necessary for a plain duplex pump, and consequently requiring less boiler capacity.

The steam, after use in the high pressure steam cylinders, is expanded into the low pressure steam cylinders, without complication of working parts, or expensive valve gear.

Proprietors of large buildings, managers of public institutions, and officers of town and village water works, will fully appreciate the advantages gained by the use of the compound system, as the saving in fuel will more than justify the additional first cost over the ordinary duplex pumps.

The engraving opposite shows our Compound Duplex Pump, with "Standard" piston pattern water end.

SIZES, CAPACITIES AND PRICES:

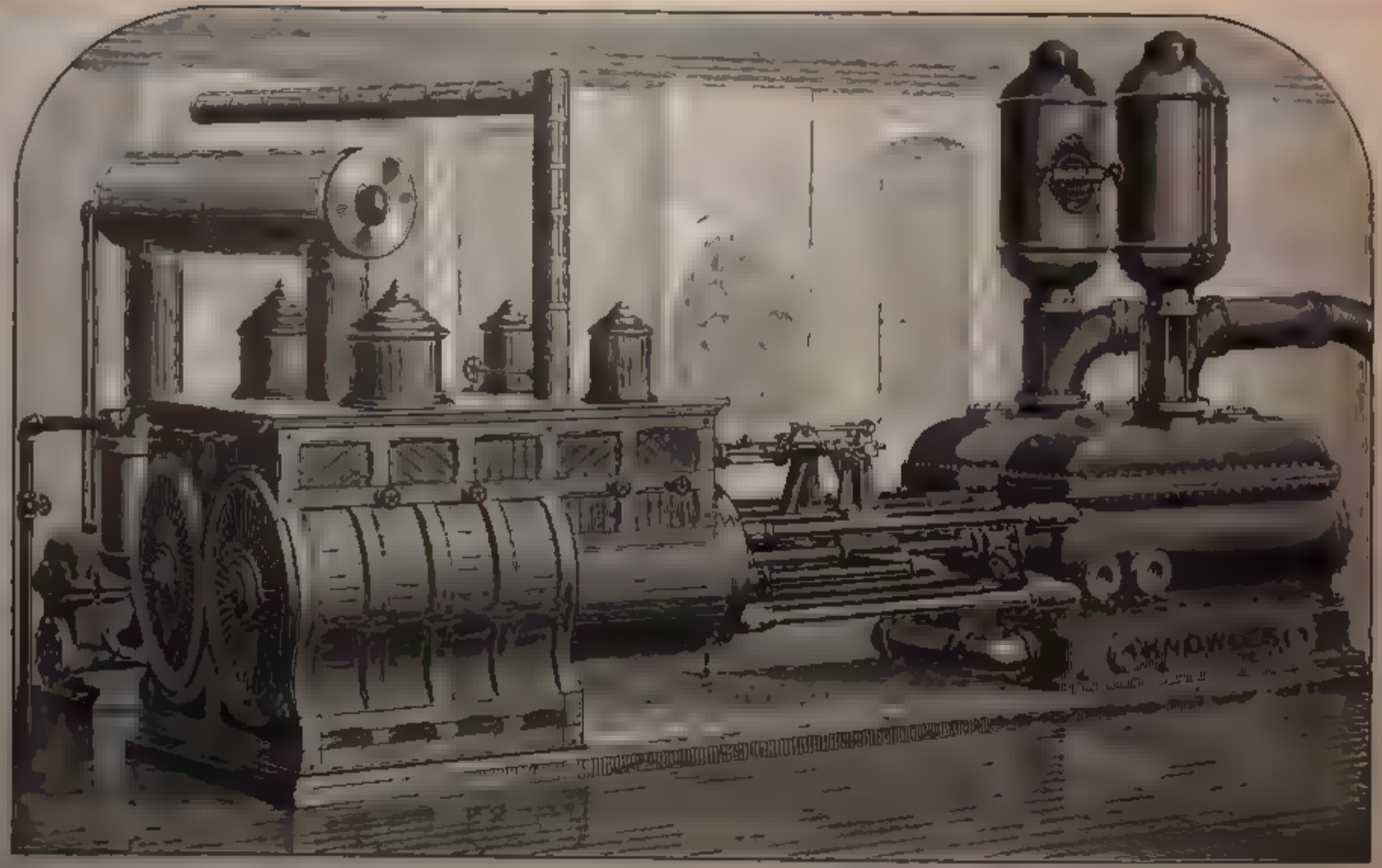
High Pressure Steam Cylinders. Inches.	Low Pressure Steam Cylinders. Inches.	Water Plungers, Inches.	Stroke. Inches.	Gallons per Stroke of each Piston.	Strokes per Minute of each Piston.	Capacity of both Water Cylinders at Speed Stated (per Minute) Gallons.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipe. Inches.	Delivery Pipe. Inches.	Price.
8 and 12		6	12	1.47	50 to 100	147 to 294	2	2½	5	4	
8 and 12		7	12	2.00	50 to 100	200 to 400	2	2½	6	5	
8 and 12		8½	12	3.00	50 to 100	300 to 600	2	2½	6	5	
8 and 12		10½	12	4.50	50 to 100	450 to 900	2	2½	8	7	
8 and 12		12	12	5.87	50 to 100	587 to 1174	2	2½	10	8	
10 and 16		8½	12	3.00	50 to 100	300 to 600	2	4	6	5	
10 and 16		10½	12	4.50	50 to 100	450 to 900	2	4	8	7	
10 and 16		12	12	5.87	50 to 100	587 to 1174	2	4	10	8	
12 and 18		10½	12	4.50	50 to 100	450 to 900	2	4	8	7	
12 and 18		10½	18	6.75	35 to 70	540 to 900	2	4			
12 and 18		12	12	5.87	50 to 100	587 to 1174	2	4			
12 and 18		12	18	8.80	40 to 70	704 to 1174	2	4			
12 and 18		14	12	8.00	50 to 100	800 to 1600	2	4			
12 and 18		14	18	12.00	40 to 70	960 to 1680	2	4			
14 and 20		10½	18	6.75	40 to 70	540 to 900	3	6			
14 and 20		12	18	8.80	40 to 70	704 to 1174	3	6			
14 and 20		14	18	12.00	40 to 70	960 to 1680	3	6			

The steam cylinders of above pumps are proportioned to use steam at a pressure of not less than 40 lbs., and not exceeding 60 lbs., in order to secure the best economic results.

When it is desired to increase the water pressure, as in case of fire, etc., a branch pipe from the regular steam connection should be made to the low pressure cylinders, when pump is piped up. The valve on this connection can be opened sufficiently to give the amount of direct steam from boiler that may be necessary to secure the water pressure desired.

*** The application of our Independent Air Pump and Condenser (particulars of which are given on pages 54 and 55) to the larger sizes of above pumps, serves to increase their economy to a still higher degree, and also does away with the noise and nuisance of steam exhausting into the atmosphere.

COMPOUND CONDENSING DUPLEX PUMPING ENGINES FOR WATER WORKS, etc., see next two pages.



KNOWLES IMPROVED COMPOUND CONDENSING DUPLEX PUMPING ENGINE.

With Independent Air Pump and Condenser.

KNOWLES IMPROVED
COMPOUND CONDENSING PUMPING ENGINES.

DIRECT-ACTING DUPLEX PATTERN.

For Water Works Service of Cities, Towns and Villages, Iron and Steel Works, etc.

THE Direct-Acting Compound Condensing Pumping Engines of Knowles Improved Duplex type are, without exception, the most desirable pumping engines that can be adopted for use in water works pumping stations, and other places where strict *economy* in the consumption of fuel is considered. These pumping engines are built from new designs combining the latest improvements, and we can confidently say that they are models of superior workmanship, economy and efficiency.

They are considerably less expensive in first cost, and require less attention and repairs, than any form of rotative or "Cornish" pumping engines in use. No costly engine houses or massive foundations are necessary; while the economical advantages resulting from the expansion and condensation of steam are very effectively obtained without the complication of parts, such as cranks, fly-wheels, eccentrics, journals, connecting rods, slides, working-beams, etc., which are always liable to derangement and subject to lost motion and excessive friction, to say nothing of the expense for the increased attendance, lubricants, etc.

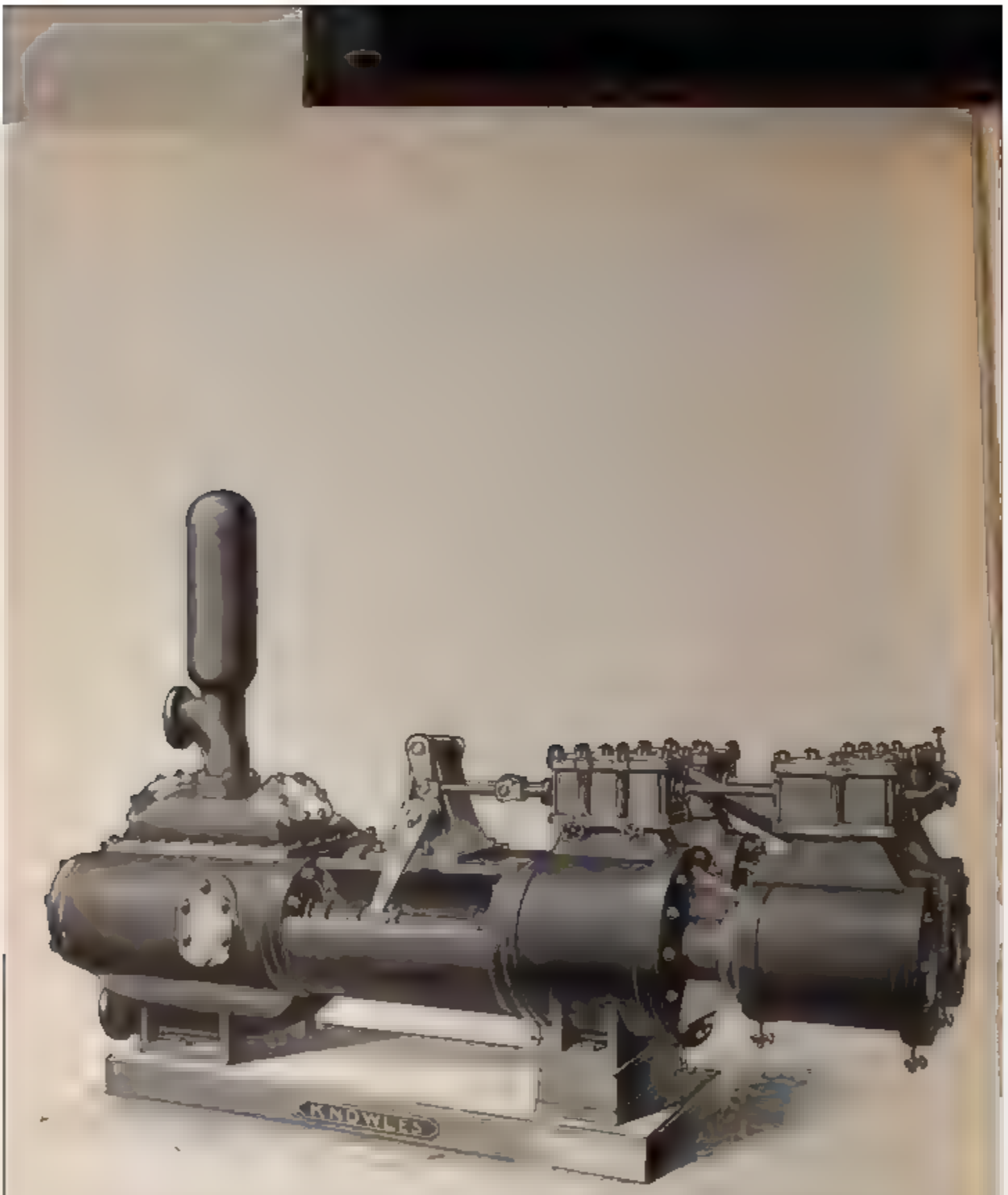
In these Improved Pumping Engines there are but two sets of working parts —*i. e.*, the main piston-rods with their steam pistons and water-plungers, and the steam valves with their valve rods and valve gear.

Having a full set of patterns for all sizes—from one million to fifteen million gallons capacity per diem—and superior manufacturing facilities, we are prepared to construct and erect at short notice the most complete pumping works. We desire to call the attention of water boards and committees to the fact that we have

MORE THAN 3000 KNOWLES PUMPING ENGINES

in operation in water works of the cities and towns of this country and abroad.

The Air-Pump and Jet Condenser (shown in opposite engraving) have no mechanical connection, and being self-contained can be operated independently and a vacuum formed for the engine before it is started. The speed of the air-pump can also be regulated according to the temperature of the injection water and the requirements of the pumping engine. The power necessary to run this pump is about one-half that usually consumed by the best type of *connected* air-pumps. There is no *drag* on the pumping engine, which is a very important feature. It may be placed in any convenient place in or below the engine room. It will maintain a steady and uniform vacuum (and as high as may be required), no matter how variable the load on the pumping engine may be.



KNOWLES COMPOUND SPECIAL NON-CONDENSING
DUPLEX PUMP.

THE KNOWLES SPECIAL

COMPOUND DUPLEX PUMP.

PISTON PATTERN.

IN pumps of this type the steam is used expansively, thus securing a marked economy in fuel consumption. This is the favorite form of pump for operating hydraulic elevators, and for furnishing water supply for small cities and towns. The efficiency of these pumps in steam consumption may be still further increased by using in connection with them our independent air pump with jet or surface condenser. When so used, the ratio between the sizes of high and low pressure steam cylinders is changed, and carefully proportioned so as to secure the greatest efficiency for the pump, under the given conditions.

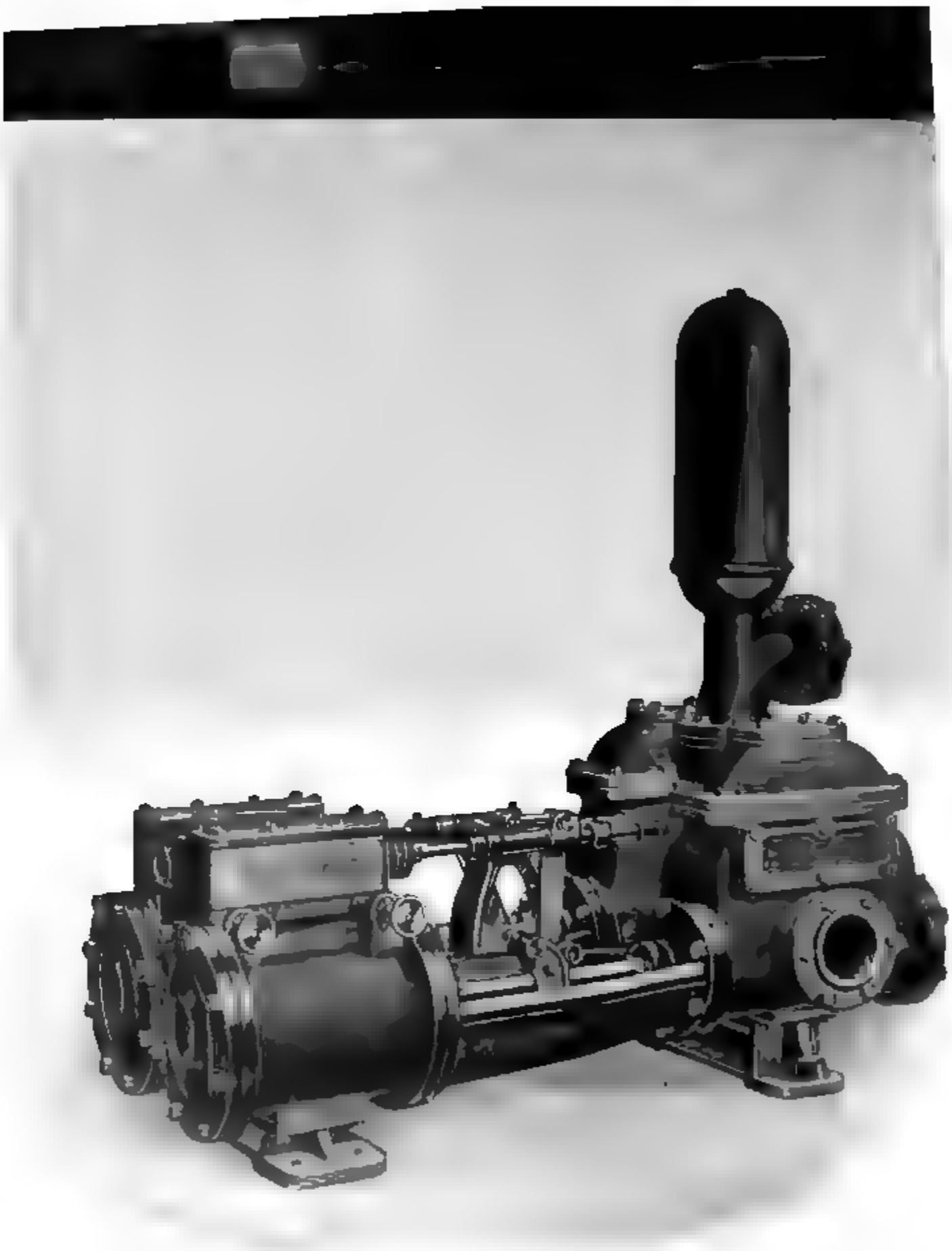
In sending inquiries or orders, always specify the steam and water pressures, and the capacity required.

High Pressure Steam Cylinders	Low Pressure Steam Cylinders	Water Cylinders	Stroke	Capacity, in Gallons per Stroke, each Piston.	Strokes per Minute, each Piston	Capacity of Both Cylinders, in Gallons, per Minute.	Steam Pipe	Exhaust Pipe	Suction Pipe.	Discharge Pipe	Telegraphic Code Word.
Ins.	Ins.	Ins.	Ins.				Ins	Ins.	Ins.	In	
5¼	7½	4	6	33	100 to 150	66 to 100	¾	2	4	3	Gangue
5¼	7½	4½	6	42	100 " 150	85 " 125	¾	2	4	3	Gangweek
5¼	7½	5	6	51	100 " 150	100 " 150	1	2	4	3	Ganil
5¼	7½	4½	10	69	75 " 125	100 " 170	1¼	3	4	3	Gannet
5¼	7½	5	10	85	75 " 125	125 " 210	1¼	2	4	3	Ganoid
6	10	5	10	85	75 " 125	125 " 210	1¼	2½	4	3	Gantlet
6	10	6	10	1 22	75 " 125	180 " 300	1¼	2½	5	4	Ganza
6	10	7	10	1 66	75 " 125	245 " 410	1¼	2½	6	5	Gaper
8	12	7	10	1 66	75 " 125	245 " 410	2	3	6	5	Garagay
10	16	7	10	1 66	75 " 125	245 " 410	2	3	6	5	Garbed
6	10	8½	10	2 45	75 " 125	365 " 610	1¼	2½	6	5	Garbled
8	12	8½	10	2 45	75 " 125	365 " 610	2	3	6	5	Garbling
10	16	8½	10	2 45	75 " 125	365 " 610	2	3	6	5	Garboard
12	18½	8½	10	2 45	75 " 125	365 " 610	2½	3½	6	5	Garboil
14	20	8½	10	2 45	75 " 125	365 " 610	2½	5	6	5	Gardened
6	10	10¼	10	3 57	75 " 125	540 " 890	1¼	2½	8	7	Garfish
8	12	10¼	10	3 57	75 " 125	540 " 890	2	3	8	7	Gargil
10	16	10¼	10	3 57	75 " 125	540 " 890	2	3	8		Gargling
12	18½	10¼	10	3 57	75 " 125	540 " 890	2½	3½			Garish
14	20	10¼	10	3 57	75 " 125	540 " 890	2½	5			Garner
6	10	12	10	4 89	75 " 125	735 " 1220	1¼	2½			Garnered
8	12	12	10	4 89	75 " 125	735 " 1220	2	3	10		Garous
10	16	12		4 89	75 " 125	735 " 1220	2	3			Garran
12	18½	12		4 89	75 " 125	735 " 1220	2½	3½		8	Garreted
14	20	12		4 89	75 " 125	735 " 1220	2½	5	10	8	Garrote
8	12	14		6 66	75 " 125	990 " 1660	2	3		10	Garum
10	16	14		6 66	75 " 125	990 " 1660	2	3		10	Gascon
12	18½	14	10	6 66	75 " 125	990 " 1660	2½	3½			Gashed
14	20	14	10	6 66	75 " 125	990 " 1660	2½	5		10	Gashful

ALSO PATTERNS FOR LARGER SIZES.

A slight additional charge is made when pumps are fitted with brass pistons and brass piston rods.

To designate the sizes, give the diameter of steam and water cylinders, and length of stroke, or use code word.



KNOWLES IMPROVED DUPLEX TANK PUMP.

"STANDARD" (Long Stroke) PISTON PATTERN.

95-A

KNOWLES IMPROVED

DUPLEX TANK PUMPS.

"STANDARD" (Long Stroke) PISTON PATTERN

For Light Service, Etc.

FOR pumping water or other liquids to limited heights and distances these pumps possess special advantages: they combine *large pumping capacity* with small expenditure of steam. They are largely used for railroad water stations and general tank supply. The steam cylinders, in proportion to the water cylinders, are made smaller in diameter than with the regular pressure pumps, consequently the first cost is less—for *amount* of water pumped. These pumps are principally used at railroad water stations, gas and oil works, bleacheries, tanneries, refineries, plantations, distilleries, etc. A variety of valves are used best adapted for pumping hot, cold, thick, thin, salt, alkaline, or other liquids. The water pistons are packed with adjustable packing of special make, and the water cylinders are brass lined.

SIZES, CAPACITIES AND PRICES.

Steam Cylinders. Inches.	Water Cylinders. Inches.	Stroke. Inches.	Gallons per Stroke each Piston.	Strokes per Minute of each Piston, ordinary Speed.	Capacity of both Water Cylinders at Speed stated per Minute. Gallons.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipe. Inches.	Delivery Pipe. Inches.	Prices.
3	2¾	3	.08	75 to 150	15 to 24	¾	½	2	1½	
4	3¾	4	.23	75 to 150	36 to 72	½	¾	2½	1½	
4½	4½	4	.23	75 to 150	36 to 72	¾	¾	2½	2½	
5	5	6	.50	75 to 125	75 to 150	¾	1¼	3	2½	
5½	5½	7	.78	75 to 125	115 to 132	1	1½	4	3	
6	6	12	1 02	50 to 100	102 to 204	1	1½	5	4	
6	6	12	1 47	50 to 100	147 to 294	1	1½	5	4	
7	8½	7	1 75	75 to 125	262 to 430	1	1½	6	5	
8	6	16	1 22	50 to 100	122 to 244	1½	1½	5	4	
8	7½	10	1 91	50 to 100	192 to 332	1½	1½	6	5	
8	7	12	2 00	50 to 100	200 to 400	1½	1½	6	5	
8	8½	12	3 00	50 to 100	300 to 600	1½	1½	6	5	
8	10½	12	4 50	50 to 100	450 to 900	1½	1½	8	7	
10	8½	12	3 00	50 to 100	300 to 600	2	2½	6	5	
10	10½	12	4.50	50 to 100	450 to 900	2	2½	8	7	
10	12	12	5 87	50 to 100	587 to 1174	2	2½	10	9	
12	10½	12	4 50	50 to 100	450 to 900	2	2½	8	7	
12	12	12	5.87	50 to 100	587 to 1174	2	2½	10	8	
12	14	12	8.00	50 to 100	800 to 1600	2	2½	12	10	
14	12	12	5.87	50 to 100	587 to 1174	2½	3	10	8	
14	14	12	8 00	50 to 100	800 to 1600	2½	3	12	10	
14	14	18	12.00	40 to 70	960 to 1680	2½	3			
14	15	18	13 50	40 to 70	1090 to 1890	2½	3			
14	16	18	15.66	40 to 70	1248 to 2192	2½	3			
16	14	18	12 00	40 to 70	960 to 1680	3	3			
16	15	18	13 50	40 to 70	1090 to 1890	3	3			
16	16	18	15 66	40 to 70	1248 to 2192	3	3			

ALSO PATTERNS FOR LARGER SIZES AND OTHER COMBINATIONS.

Pumps Fitted with Composition Piston Rods, etc., at a slight additional charge.

Auxiliary Boiler-Feed Pumps (single-acting plungers) attached, when ordered, at a slight additional charge.

☞ In ordering Duplex Pumps parties will please state fully the duty to be performed, *i. e.*, the elevation the water has to be pumped and the length and diameter of suction and discharge pipes, etc.

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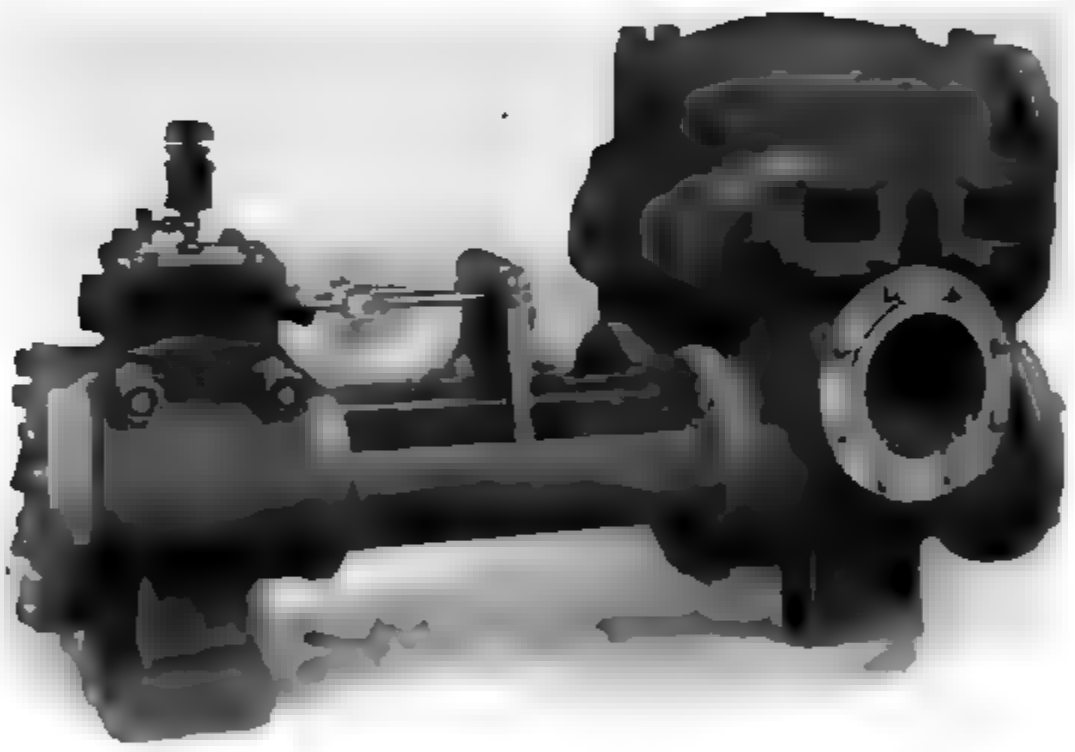


KNOWLES SPECIAL DUPLEX TANK PUMP.

Size, 8x10½x10.

The Knowles Special Duplex Pump.

Tank, or Light Service Pattern.

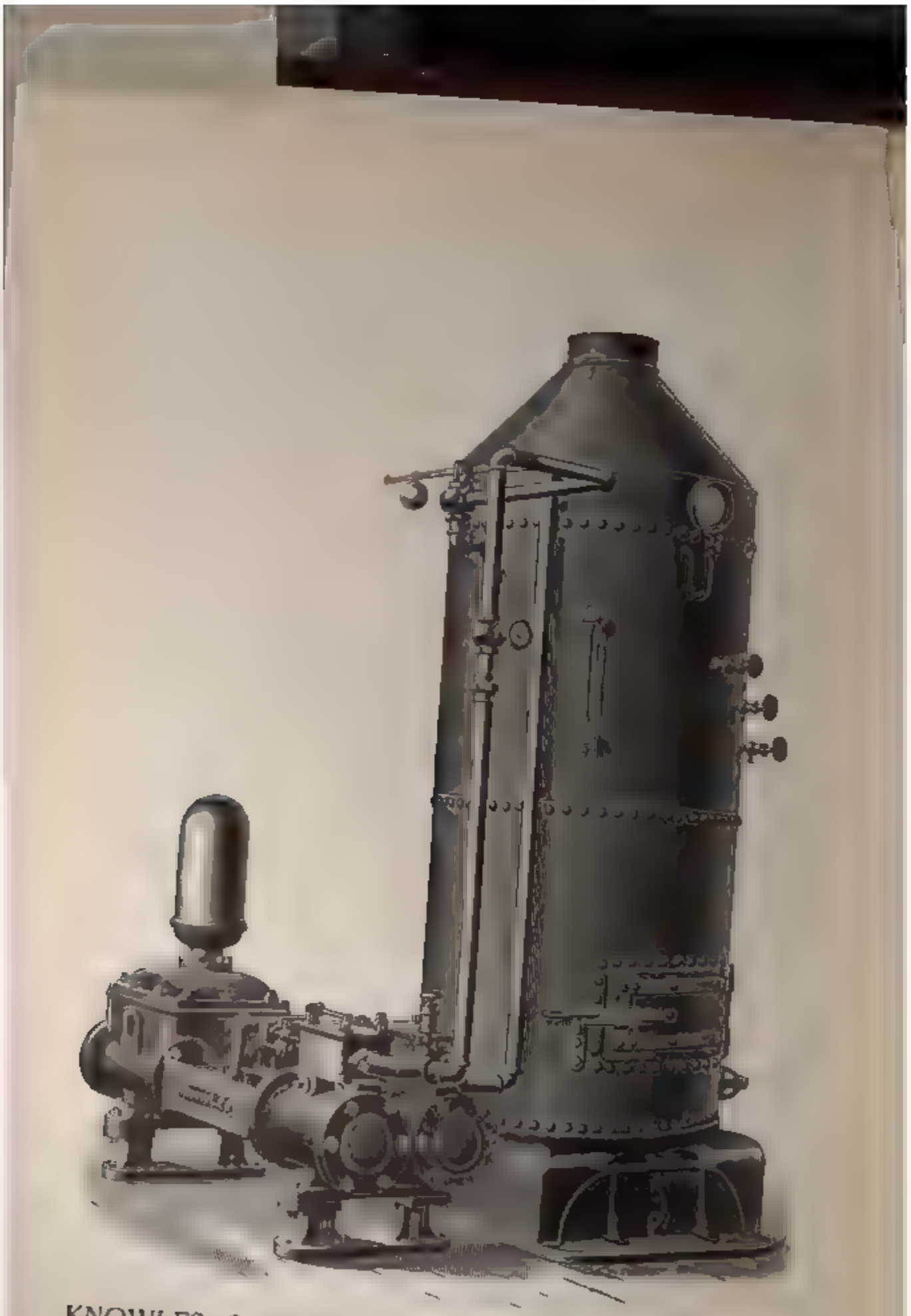
THESE pumps are designed for use where the liquid handled is to be raised only to a moderate height. They are made of the piston pattern, pump pistons fibrous cked, and they are furnished with valves of hard or soft rubber, or of metal, as required, cording to the liquid to be handled. Water cylinders are brass lined.

Cylinders.	Water Cylinders.	Stroke.	Capacity in Gallons per Stroke, each Piston.	Strokes per Minute, each Piston.	Capacity of Both Cylinders, in Gallons per Minute.	Steam Pipe	Exhaust Pipe	Suction Pipe.	Discharge Pipe.	Telegraphic Code Word.	
.	Ins.	Ins.				Ins.	Ins.	Ins.	Ins.	Regular.	Brass Fitted.
	2¾	3	.08	100 to 200	15 to 30	⅜	½	1¼	1	Geerbtes	Genoegen
½	3¾	4	.20	100 to 200	40 to 80	½	¾	2½	1½	Geese	Genoemd
¼	4¾	5	.38	100 " 150	75 " 110	¾	1¼	3	2½	Gelable	Genoessig
	5¾	6	.67	100 " 150	130 " 195	1	1½	4	3	Gelatine	Genoethigt
	7½	6	1.14	100 " 150	225 " 340	1	1½	6	5	Gelding	Genoffel
½	6	6	.73	100 " 150	146 " 220	1¼	1½	4	3	Gelidity	Genoilleré
½	7½	6	1.14	100 " 150	225 " 340	1¼	1½	6	5	Geminate	Genoodigd
	8½	6	1.47	100 " 150	295 " 440	1	1½	6	5	Gemmary	Genoper
½	8½	6	1.47	100 " 150	295 " 440	1¼	1½	6	5	Gemmated	Genoplesio
½	6	10	1.22	75 " 125	180 " 300	1¼	1½	5	4	Gemmule	Genopt
½	7	10	1.66	75 " 125	245 " 410	1¼	1½	6	5	Gendarme	Genosiride
	7	10	1.66	75 " 125	245 " 410	1½	2	6	5	Gender	Genovesas
	7½	10	1.91	75 " 125	285 " 475	1½	2	6	5	Genearch	Genoveva
½	8½	10	2.45	75 " 125	365 " 610	1¼	1½	6	5	General	Genrebild
	8½	10	2.45	75 " 125	365 " 610	1½	2	6	5	Generant	Genteelish
	8½	10	2.45	75 " 125	365 " 610	1½	2	6	5	Generate	Genterella
	10¼	10	3.57	75 " 125	530 " 890	1½	2	[illegible]	7	Generating	Gentezinha
	10¼	10	3.57	75 " 125	530 " 890	1½	2	[illegible]	7	Generic	Genthios
	10½	10	3.75	75 " 125	560 " 935	2½	3	[illegible]	7	Generical	Genthite
	10½	10	3.75	75 " 125	560 " 935	2½	3	[illegible]	7	Generosity	Genticae
	12	10	4.89	75 " 125	730 " 1220	1½	2	10	[illegible]	Generous	Genticorum
	12	10	4.89	75 " 125	730 " 1220	2½	3	10	[illegible]	Genesis	Genticum
	12	10	4.89	75 " 125	730 " 1220	2½	3	10	[illegible]	Genetic	Gentilibus
	14	10	6.66	75 " 125	990 " 1660	1½	2	12	10	Genevan	Gentilino
	14	10	6.66	75 " 125	990 " 1660	2½	3	12	10	Genevese	Gentilismo
	14	10	6.66	75 " 125	990 " 1660	2½	3	12	10	Genially	Gentilitas

ALSO PATTERNS FOR LARGER SIZES.

A slight additional charge is made when pumps are fitted with brass pistons and ass piston rods.

To designate the sizes give the diameter of steam and water cylinders, and length stroke, or use code word.



KNOWLES COMBINED DUPLEX PUMP AND BOILER,

WITH FIXTURES, ETC.

[redacted]

THE KNOWLES COMBINED SPECIAL
DUPLEX PUMP AND BOILER.

REGULAR UPRIGHT TUBULAR BOILER.

COMPLETE WITH AUXILIARY BOILER FEED PUMP, BASE PLATE, SMOKE BONNET, GRATE BARS, GAUGE COCKS, STEAM GAUGE, WATER GAUGE, SAFETY VALVE, GLOBE VALVES, BLOW-OFF COCKS, STEAM AND EXHAUST PIPES, BOILER FEED CONNECTION, VALVES, UNIONS AND NECESSARY FITTINGS, ETC.

THIS combination of Duplex Steam Pump, with upright tubular boiler and fixtures complete is the most compact, serviceable and inexpensive machine of its kind for supplying water to hotels, public buildings, and residences; also for use at railroad water stations, brick-yards, tanneries, quarries, plantations, etc

The attention of plantation owners is particularly called to the especial advantage of this light, portable and convenient pumping apparatus for the water supply for irrigating purposes, etc. The entire machine can be placed at the point from which the water is to be taken, and the water forced to any distance and height required.

The whole apparatus is of the best manufacture, the boiler being perfectly safe and guaranteed to 100 pounds pressure (tested to 200 pounds) per square inch. When water is to be forced not higher than 50 to 75 feet, the "Tank Pumps" are preferable and less expensive Auxiliary Plunger Pumps, for feeding the boilers are attached to all light service pumps without additional charge.

REGULAR PATTERN FOR GENERAL SERVICE.

Steam Cylinders.	Water Cylinders.	Stroke.	Gallons per Stroke, Each Piston.	Strokes per Minute, Each Piston	Capacity of Both Cylinders at Speed stated per Minute.	Steam Pipe	Exhaust Pipe	Suction Pipe	Delivery Pipe.	Telegraphic Code Word
Inches	Inches	Ins			Gallons.	Ins	Ins	Ins.	Ins	
3	2	3	.04	100 to 250	8 to 20	⅜	½	1¼	1	Gladden
4½	2¾	4	.10	100 " 200	20 " 40	½	¾	2	1½	Gladding
5¼	3½	5	.20	100 " 200	40 " 80	¾	1¼	2½	1½	Gladly
6	4	6	.33	100 " 150	66 " 100	1	1½	3	2	Gladness
7½	4½	6	.42	100 " 150	85 " 125	1½	2	4	3	Gladsome
7½	5	6	.51	100 " 150	100 " 150	1½	2	4	3	Gladwin
7½	4½	10	.69	75 " 125	100 " 170	1½	2	4	3	Glamour
9	5¼	10	.93	75 " 125	135 " 230	2	2½	4	3	Glance
10	6	10	1.22	75 " 125	180 " 300	2	2½	5	4	Glancing

TANK OR "LIGHT SERVICE" PUMPS

4½	3¼	4	.20	100 to 200	40 to 80	½	¾	2½	1½	Glanders
5¼	4¼	5	.38	100 " 150	75 " 110	¾	1¼	3	2½	Glandule
6	5¼	6	.67	100 " 150	130 " 195	1	1½	4	3	Glaring
6	7½	6	1.14	100 " 150	225 " 340	1	1½	6	5	Glassy
7½	7½	6	1.14	100 " 150	225 " 340	1½	2	6	5	Glazier
6	8½	6	1.47	100 " 150	295 " 440	1	1½	6	5	Gleaming
7½	6	10	1.22	75 " 125	180 " 300	1½	2	5	4	Gleaner
7½	7	10	1.66	75 " 125	245 " 410	1½	2	6	5	Glebe
7½	8½	10	2.45	75 " 125	365 " 610	1½	2	6	5	Gleeful
10	8½	10	2.45	75 " 125	365 " 610	2	2½	6	5	Gleety

ALSO PATTERNS FOR LARGER SIZES.

A slight additional charge is made when pumps are fitted with brass pistons or plungers, and brass piston rods. To designate the sizes, give the diameter of steam and water cylinders and length of stroke, or use code word.

THE KNOWLES UNDERWRITER FIRE PUMP.

Size, 18x.ox12.

1000 gallons per minute

THE KNOWLES
UNDERWRITER FIRE PUMP.

MUTUAL INSURANCE COMPANIES' SPECIFICATIONS.

IN our Underwriter Fire Pump, the water passages, valve areas, and suction and discharge nozzles are all much larger than in any ordinary pump, so a greater amount of water can be discharged without water-hammer. Also, the steam and exhaust ports and nozzles are designed so as to give unrestricted passage to the steam. The pump is "rust-proof," and will start instantly, after standing unused for a long time. The piston rods and valve rods are made from Tobin bronze. All stuffing-boxes and glands are brass lined. Plungers and plunger sleeve are of composition, but the metals are differently mixed to prevent cutting. This mixture of the metals has been a subject of much experiment and study; it has now brought us great success, as the parts work perfectly upon each other, without friction or impairment.

Each pump has the following fittings, heretofore charged as extras, but now included in the price and regularly furnished:

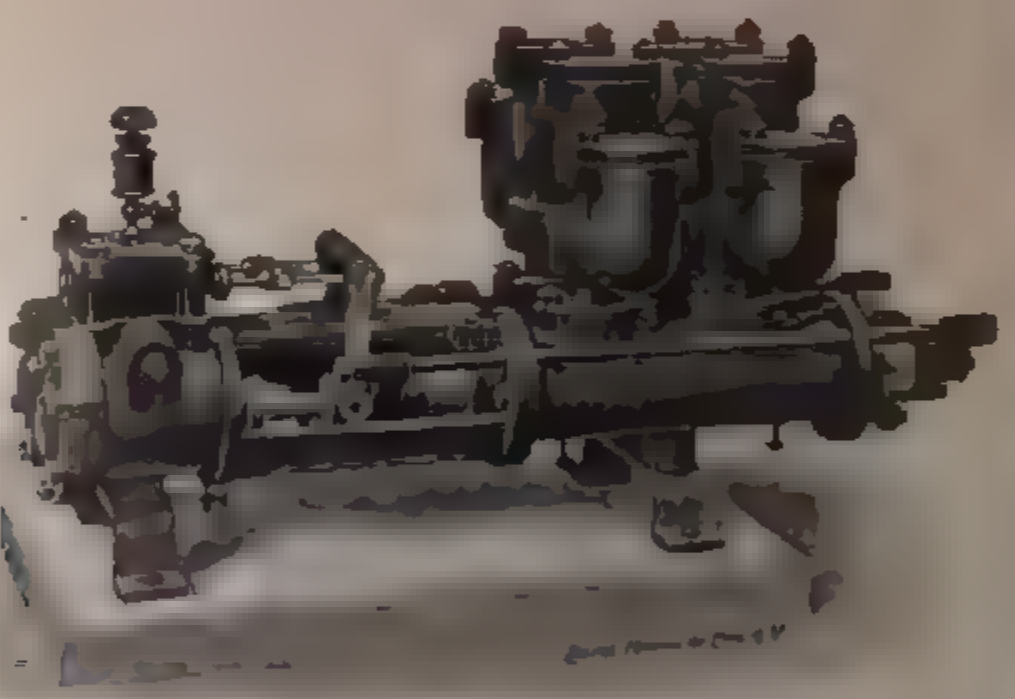
Capacity-Plate on Discharge Air-Chamber.
Stroke-Gauge, graduated on each end.
Vacuum, or Suction Air-Chamber.
Steam-Gauge, 5 inches diameter.
Water-Gauge, 5 inches diameter, with duplex spring.
Relief-Valve of large capacity.
Relief-Valve Discharge-Cone.
Set of brass priming Pipes and special valves.
Required number of 2½ inches Ludlow Hose-Valves.
One pint Sight-Feed Cylinder-Lubricator.
All according to the specifications.

On account of the larger passageways, brass parts and attachments mentioned, the pump necessarily costs more than an ordinary fire pump; but the cost by the gallon discharged is less, since the Underwriter pump can deliver a greater quantity of water in the same length of time. It is also much heavier and stronger, with superior workmanship, and better protected from rust and accident.

TABLE OF SIZES AND CAPACITIES.

Diameter of Steam Cylinders.	Diameter of Water Plungers.	Length of Stroke.	Normal Capacities. Gallons per Minute.	Number of Fire Streams.	Steam Pipe.	Exhaust Pipe.	Suction Pipe.	Discharge Pipe.	Code Word.
12	6	12	320	1	2½	3	6	5	Ensign
14	7¼	12	500	2	3	4	8	6	Ensigncy
16	9	12	750	3	3½	4	10	7	Enskied
18	10	12	1000	4	4	5	12	8	Enslave
20	12	16	1500	6	5	6	14	10	Ensnarl

The actual capacity of each pump is more than the Underwriters' rating, and a greater speed can be attained, that will increase the number of fire streams.



KNOWLES SPECIAL DUPLEX PUMP.

OUTSIDE PACKED PLUNGER PATTERN.

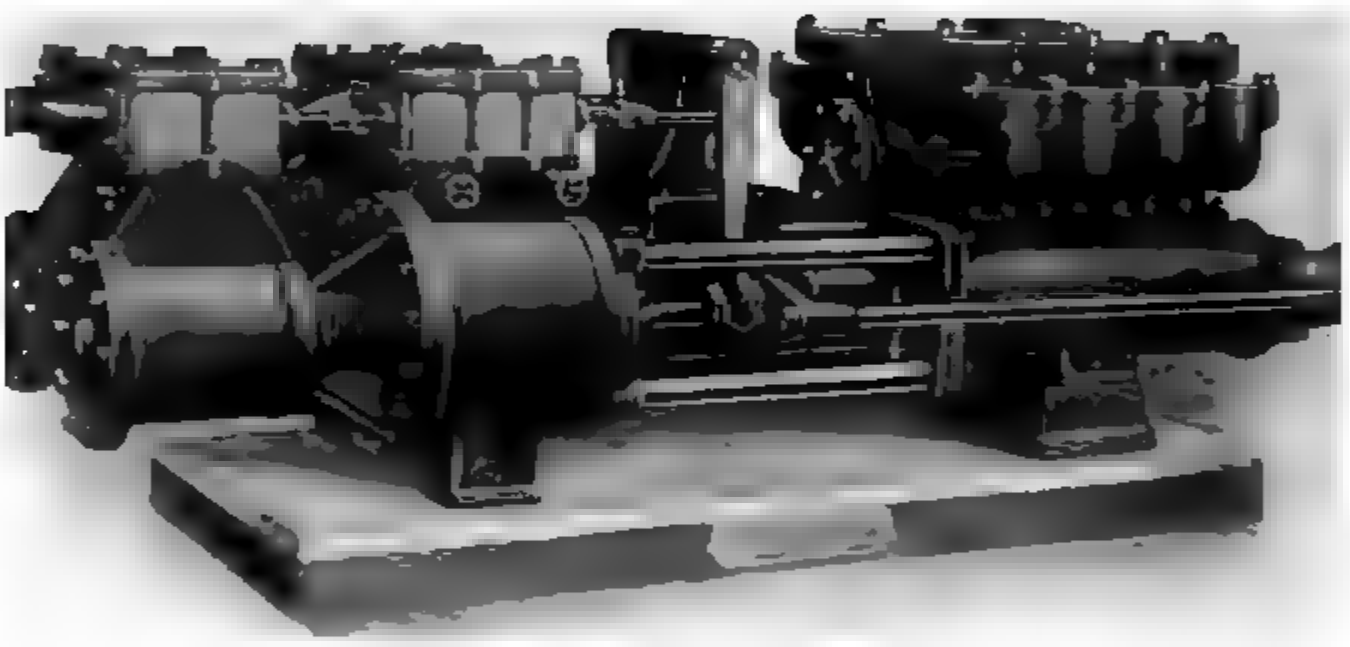
Size, 5½x3x5.

THE KNOWLES
SPECIAL DUPLEX PUMP

OUTSIDE PACKED PLUNGER PATTERN.

THIS pattern of pump is specially designed for pipe lines, for mining purposes, for feeding boil carrying very high steam pressures in conformity with the most modern practice, or for any serv requiring the delivery of liquids under unusually heavy pressure, not to exceed 250 to 450 pounds square inch. Owing to the facility with which wear in the water plungers may be taken up, by sett out the packing in the stuffing boxes, these pumps are specially well suited for handling gritty liqui

Steam Cylinders.	Water Plungers.	Stroke.	Capacity in Gallons per Stroke, each Plunger.	Strokes per Minute, each Plunger.	Capacity of Both Cylinders in Gallons, per Minute.	Steam Pipe.	Exhaust Pipe.	Suction Pipe.	Discharge Pipe.	Water Pressure Pump End will stand, in lbs., per square inch.	Telegraphic Code Word.	
Ins.	Ins.	Ins.				Ins.	Ins.	Ins.	Ins.		Regular	Brass Fitte
3	2	3	.04	100 to 200	8 to 16	⅜	½	1¼	1	300	Gimbal	Gimmal
4½	2	4	.08	100 " 200	16 " 32	⅝	¾	1½	1¼	300	Gimlet	Gimnasia
4½	2½	4	.08	100 " 200	16 " 32	⅝	¾	1½	2	300	Gimlety	Gimnastun
5½	3	5	.15	100 " 200	30 " 60	¾	1	2	2	300	Gimmer	Gimnico
6	3½	6	.25	100 " 150	50 " 75	1	1¼	2½	2	300	Gimp	Gimnoderm
6	4	6	.33	100 " 150	67 " 100	1	1½	3	2½	300	Gimpy	Gimnorinc
7½	4	6	.33	100 " 150	67 " 100	1¼	1½	3	2½	300	Gin	Gimpelfarp
7½	4½	6	.42	100 " 150	85 " 125	1¼	1½	4	3	300	Ginger	Gimpelgelt
7½	5	6	.51	100 " 150	100 " 150	1¼	1½	4	3	300	Gingerbread	Gimpelhaft
7½	4½	10	.69	50 " 100	69 " 138	1¼	1½	4	3	300	Gingerly	Gimpmueh
7½	5	10	.85	50 " 100	85 " 170	1¼	1½	4	3	300	Gingham	Ginandria
10	4	10	.54	50 " 100	54 " 108	1½	2	4	3	250	Gingiber	Ginantropo
10	4	10	.54	50 " 100	54 " 108	1½	2	4	3	450	Gingivitis	Ginclanes
10	5	10	.85	50 " 100	85 " 170	1½	2	4	3	250	Gingko	Gindarus
10	5	20	1.02	50 " 100	102 " 204	1½	2	4	3	250	Gingle	Ginebrada
10	6	10	1.22	50 " 100	122 " 244	1½	2	5	4	250	Gingo	Gineconan
10	6	12	1.47	50 " 100	147 " 294	1½	2	5	4	250	Gingrich	Ginestrina
12	4	10	.54	50 " 100	54 " 108	2⅛	3	4	3	450	Gingrich	Ginetado
12	4	20	.65	50 " 100	65 " 130	2⅛	3	4	3	450	Gingrich	Gingar
12	5	10	85	50 " 100	85 " 170	2⅛	3	4	3	300	Gingrich	Gingeole
12	5	12	1 02	50 " 100	102 " 204	2⅛	3	4	3	300	Gingrich	Gingerade
12	6	10	1.22	50 " 100	122 " 244	2⅛	3	5	4	300	Gingrich	Ginmaul
12	6	12	1.47	50 " 100	147 " 294	2⅛	3	5	4	300	Gingrich	Gingernesa
12	7	10	1.66	50 " 100	166 " 332	2⅛	3	6	5	300	Gingrich	Gingibrine
12	7	12	2 00	50 " 100	200 " 400	2⅛	3	6	5	300	Gingrich	Gingidron
12	7½	10	1 91	50 " 100	191 " 382	2⅛	3	6	5	300	Gingrich	Gingilipho
12	7½	12	2.30	50 " 100	230 " 460	2⅛	3	6	5	300	Gingrich	Gingillano
14	5	10	.85	50 " 100	85 " 170	2½	3	4	3	300	Gingrich	Gingillare
14	5	12	1.02	50 " 100	102 " 204	2½	3	4	3	300	Gingrich	Gingillava
14	6	10	1.22	50 " 100	122 " 244	2½	3	5	4	300	Gingrich	Gingitic
14	6	12	1.47	50 " 100	147 " 294	2½	3	5	4	300	Gingrich	Gingival
14	6	18	2 20	40 " 80	176 " 352	2½	3	6	5	450	Gingrich	Gingivatun
14	7	10	1.66	50 " 100	166 " 332	2½	3	6	5	300	Gingrich	Gingivite
14	7	12	2.00	50 " 100	200 " 400	2½	3	6	5	300	Gingrich	Gingivula
14	7	18	3.00	40 " 80	240 " 480	2½	3	7	6	450	Gingrich	Gingivuna
14	7½	10	1 91	50 " 100	191 " 382	2½	3	6	5	300	Gingrich	Gingkosite
14	7½	12	2 30	50 " 100	230 " 460	2½	3	6	5	300	Gingrich	Ginglymo
14	8	10	2 18	50 " 100	218 " 436	2¼	3	7	6	300	Gingrich	Gingrymus
14	8	12	2 61	50 " 100	261 " 522	2½	3	7	6	300	Gingrich	Gingoule
14	8	18	3 91	40 " 80	312 " 625	2½	3	8	7	450	Gingrich	Gingriamu
14	8½	18	4.50	40 " 80	360 " 720	2½	3	8	7	400	Gingrich	Gingriendo
14	9	12	3.30	50 " 100	330 " 660	2½	3	8	7	250	Gingrich	Gingrine
14	9	18	4.95	40 " 80	396 " 792	2½	3	8	7	250	Gingrich	Gingrinla
16	5	18	.85	50 " 100	85 " 170	2¼	3	4	3	450	Gingrich	Gingrirent



THE KNOWLES COMPOUND SPECIAL DUPLEX PUMP.

Outside Packed Plunger Pattern.

Size, 10x16x7x10.

THE KNOWLES SPECIAL DUPLEX PUMP—CONTINUED.

OUTSIDE PACKED PLUNGER PATTERN.

Stroke. Ins.	Capacity, in Gallons, per Stroke each Plunger.	Strokes per Minute, each Plunger.	Capacity of Both Cylinders, in Gallons, per Minute.	Steam Pipe. Ins.	Exhaust Pipe. Ins.	Suction Pipe. Ins.	Discharge Pipe. Ins.	Water Press Pump I and will stand, in the square inch	Telegraphic Code Words. Regular	Telegraphic Code Words. Brass Lined
12	1.02	50 to 100	102 to 204	2½	3	4	3	450	Glenarda	Gladness
10	1.22	50 " 100	122 " 244	2½	3	4	4	450	Gladness	Gladsome
12	1.47	50 " 100	147 " 294	2½	3	4	4	450	Gladsome	Gladstone
18	2.20	40 " 80	176 " 352	2½	3	5	4	450	Gladstone	Gladwyn
10	1.66	50 " 100	166 " 332	2½	3	5	4	450	Gladwyn	Glamorgan
12	2.00	50 " 100	200 " 400	2½	3	5	4	450	Glamorgan	Glamorganshire
10	1.91	50 " 100	191 " 382	2½	3	5	4	450	Glamorganshire	Glamis
12	2.30	50 " 100	230 " 460	2½	3	5	4	450	Glamis	Glandwr
18	3.00	40 " 80	240 " 480	2½	3	5	4	450	Glandwr	Glandwrdeg
18	3.44	40 " 80	275 " 550	2½	3	5	4	450	Glandwrdeg	Glandwrdegs
10	2.18	50 " 100	218 " 436	2½	3	5	4	450	Glandwrdegs	Glandwrdegsh
12	2.61	50 " 100	261 " 522	2½	3	5	4	450	Glandwrdegsha	Glandwrdegshan
18	3.91	40 " 80	312 " 625	2½	3	5	4	450	Glandwrdegshan	Glandwrdegshanb
18	4.50	40 " 80	360 " 720	2½	3	5	4	450	Glandwrdegshanba	Glandwrdegshanbar
12	3.30	50 " 100	330 " 660	2½	3	5	4	450	Glandwrdegshanbarr	Glandwrdegshanbarra
18	4.95	40 " 80	396 " 792	2½	3	5	4	450	Glandwrdegshanbarra	Glandwrdegshanbarrac
10	1.66	50 " 100	166 " 332	3	3½	5	4	450	Glandwrdegshanbarrac	Glandwrdegshanbarracl
12	2.00	50 " 100	200 " 400	3	3½	5	4	450	Glandwrdegshanbarracl	Glandwrdegshanbarracle
10	1.66	50 " 100	166 " 332	3	3½	5	4	450	Glandwrdegshanbarracle	Glandwrdegshanbarracles
12	2.00	50 " 100	200 " 400	3	3½	5	4	450	Glandwrdegshanbarracles	Glandwrdegshanbarracleso
10	1.91	50 " 100	191 " 382	3	3½	5	4	450	Glandwrdegshanbarracleso	Glandwrdegshanbarracleson
12	2.30	50 " 100	230 " 460	3	3½	5	4	450	Glandwrdegshanbarracleson	Glandwrdegshanbarracleson
10	2.18	50 " 100	218 " 436	3	3½	5	4	450	Glandwrdegshanbarracleson	Glandwrdegshanbarracleson
10	2.18	50 " 100	218 " 436	3	3½	5	4	450	Glandwrdegshanbarracleson	Glandwrdegshanbarracleson
12	2.61	50 " 100	261 " 522	3	3½	5	4	450	Glandwrdegshanbarracleson	Glandwrdegshanbarracleson
12	2.61	50 " 100	261 " 522	3	3½	5	4	450	Glandwrdegshanbarracleson	Glandwrdegshanbarracleson
18	3.91	40 " 80	312 " 625	3	3½	5	4	450	Glandwrdegshanbarracleson	Glandwrdegshanbarracleson
18	4.50	40 " 80	360 " 720	3	3½	5	4	450	Glandwrdegshanbarracleson	Glandwrdegshanbarracleson
18	4.95	40 " 80	396 " 792	3	3½	5	4	450	Glandwrdegshanbarracleson	Glandwrdegshanbarracleson
12	4.08	50 " 100	408 " 816	3	3½	5	4	450	Glandwrdegshanbarracleson	Glandwrdegshanbarracleson
18	6.12	40 " 80	490 " 980	3	3½	5	4	450	Glandwrdegshanbarracleson	Glandwrdegshanbarracleson
12	2.61	50 " 100	261 " 522	4	5	6	4	450	Glandwrdegshanbarracleson	Glandwrdegshanbarracleson
18	3.91	40 " 80	312 " 625	4	5	6	4	450	Glandwrdegshanbarracleson	Glandwrdegshanbarracleson
18	4.50	40 " 80	360 " 720	4	5	6	4	450	Glandwrdegshanbarracleson	Glandwrdegshanbarracleson
12	3.30	50 " 100	330 " 660	4	5	6	4	450	Glandwrdegshanbarracleson	Glandwrdegshanbarracleson
18	4.95	40 " 80	396 " 792	4	5	6	4	450	Glandwrdegshanbarracleson	Glandwrdegshanbarracleson
12	4.08	50 " 100	408 " 816	4	5	6	4	450	Glandwrdegshanbarracleson	Glandwrdegshanbarracleson
18	6.12	40 " 80	490 " 980	4	5	6	4	450	Glandwrdegshanbarracleson	Glandwrdegshanbarracleson

ALSO PATTERNS FOR LARGER SIZES.

ining work, when so ordered, suction opening will be made same diameter as plunger, except 9½ inches and which will be made 7 inches and 8 inches diameter respectively. Next larger opening will be for next smaller in suction pipe. A slight additional charge is made when pumps are fitted with brass plungers. To designate ve the diameter of steam and water cylinders and length of stroke, use code word. We have also patterns of the above type suited for much heavier pressures than those named in the table. For these we will quote s on application.

COMPOUND DUPLEX PLUNGER PUMPS. CONDENSING AND NON-CONDENSING.

ave patterns from new and improved designs, embodying all the latest improvements, for different sizes of nger Pumps built on the compound plan, as illustrated on opposite page. This will work under the heaviest ith the *minimum* consumption of steam. *Estimates given on application.*

KNOWLES AUTOMATIC FEED PUMP AND RECEIVER.

Size, 6x4x6.

[redacted]

THE KNOWLES

AUTOMATIC FEED PUMP & RECEIVER

is the simplest and most effective apparatus made for draining Steam Coils, Radiators, Heaters, Drying Cylinders, Steam Jackets, etc., and forcing the water of condensation in its hottest condition direct to the steam boilers. It is perfectly reliable and automatic in its operation. It does away with the expense and annoyance of traps and tanks and returns the condensed steam to the boiler in a steady, continuous flow, as fast as it accumulates in the receiver. The Automatic Feed Pump and Receiver can be used for other purposes than a boiler-feed appliance; for instance, for regulating the brine circulation in refrigerating machinery, for the temporator apparatus in beer cooling and for other circulating purposes.

This apparatus also makes an efficient form of governor for maintaining a uniform water level in steam heating systems. When used for this purpose the receiver is placed at the height at which it is required to maintain the water line. When desired, the receiver and pump may be separated, the receiver being placed at the water line level, and the pump located below at any convenient point.

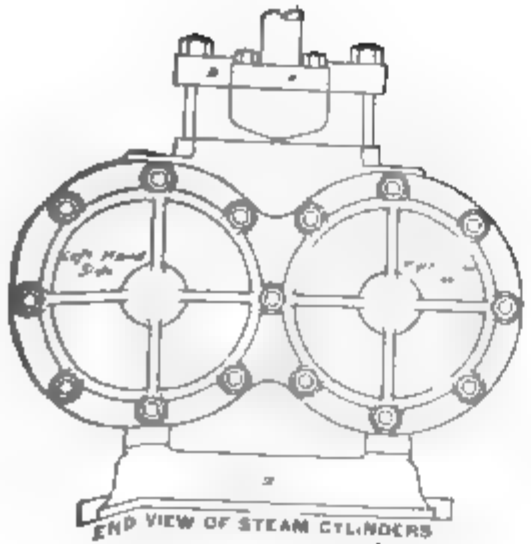
Referring to the illustration on the opposite page, it will be noticed that the condensed steam enters by the inlet nozzle at the top, and falls to the bottom of the receiver. This water cannot accumulate in any quantity, as in rising, it lifts the float, and the steam pump takes it away immediately and forces it to the boiler. The pump is operated from the float by means of the intermediate connections, and balanced steam throttle. When the float rises the pump is started, and the speed is regulated according to the quantity of water flowing into the receiver—the larger the quantity of water the faster the pump moves. The pump slows down as the supply of water drops off, and when it ceases the pump stops entirely.

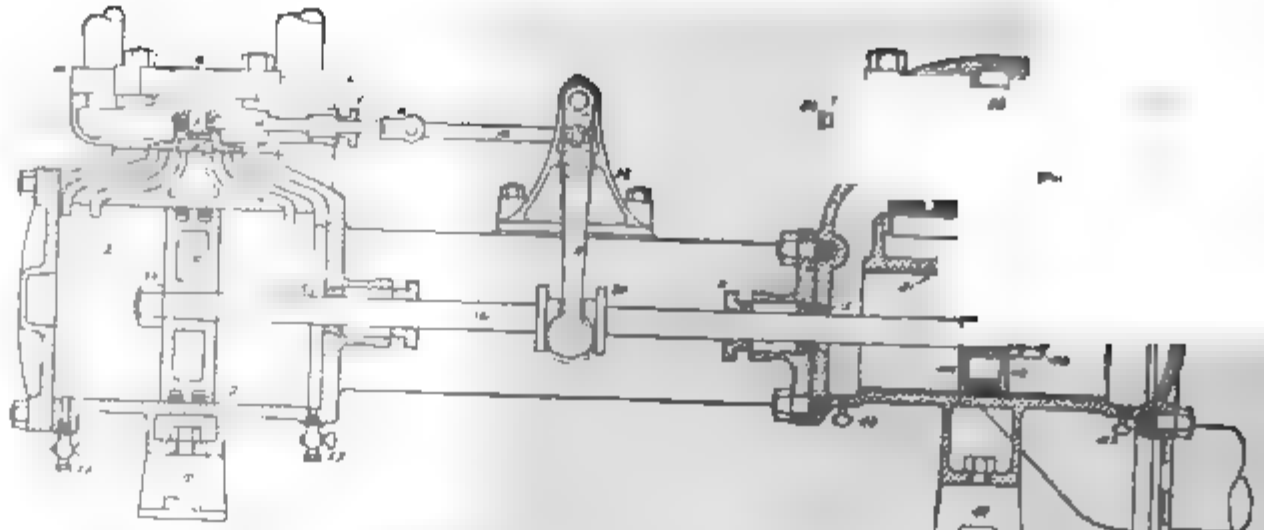
Size of Pump. (Duplex)	Square Feet of Direct Radiating Surface it will Drain.	Space Occupied, inches.			Telegraphic Code Word.	
		Length.	Width.	Height.	Regular.	Brass Fitted.
3 × 2 × 3	5,000	34	25	31	Meabilibus	Meandrous
4½ × 2¾ × 4	10,000	37	30	35	Meabilium	Meaningly
5¼ × 3½ × 5	20,000	48	37	44	Meaculam	Meapte
6 × 4 × 6	40,000	48	37	45	Meacularem	Measles
7½ × 5 × 6	70,000	54	44	48	Meadow	Meationem
7½ × 4½ × 10	70,000	63	44	48	Meagrely	Meationis

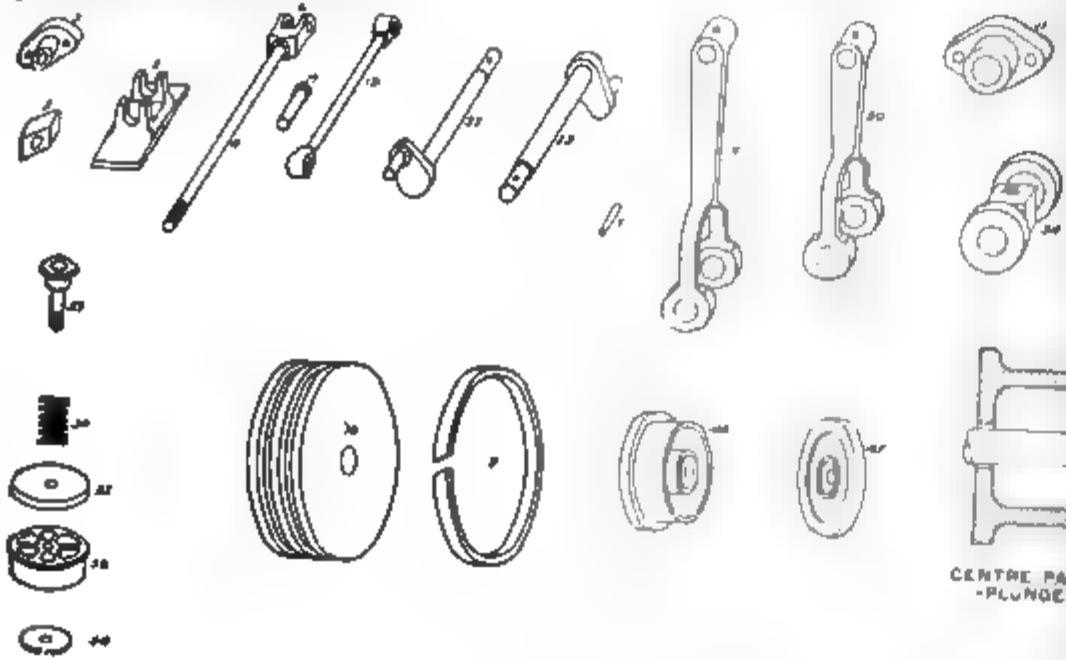
Prices include everything shown in the illustration.

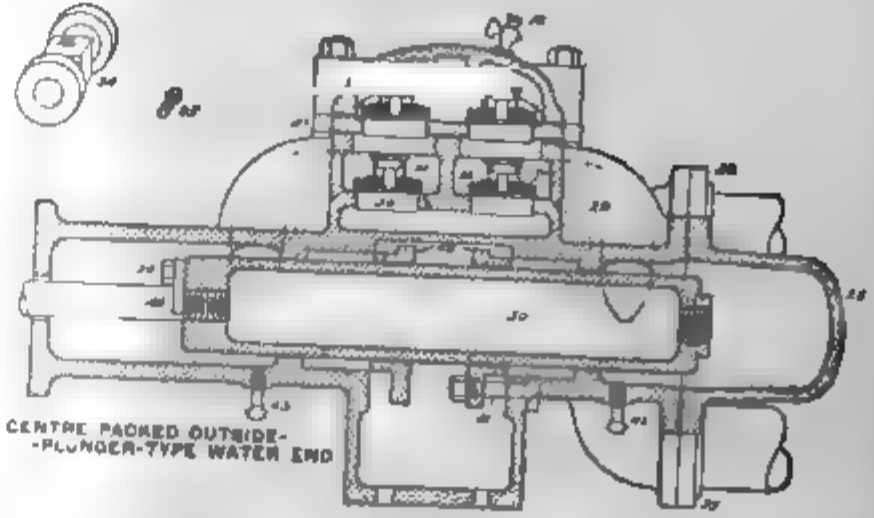
We also furnish this apparatus when required with the receiver mounted directly over the pump.

Prices upon application.









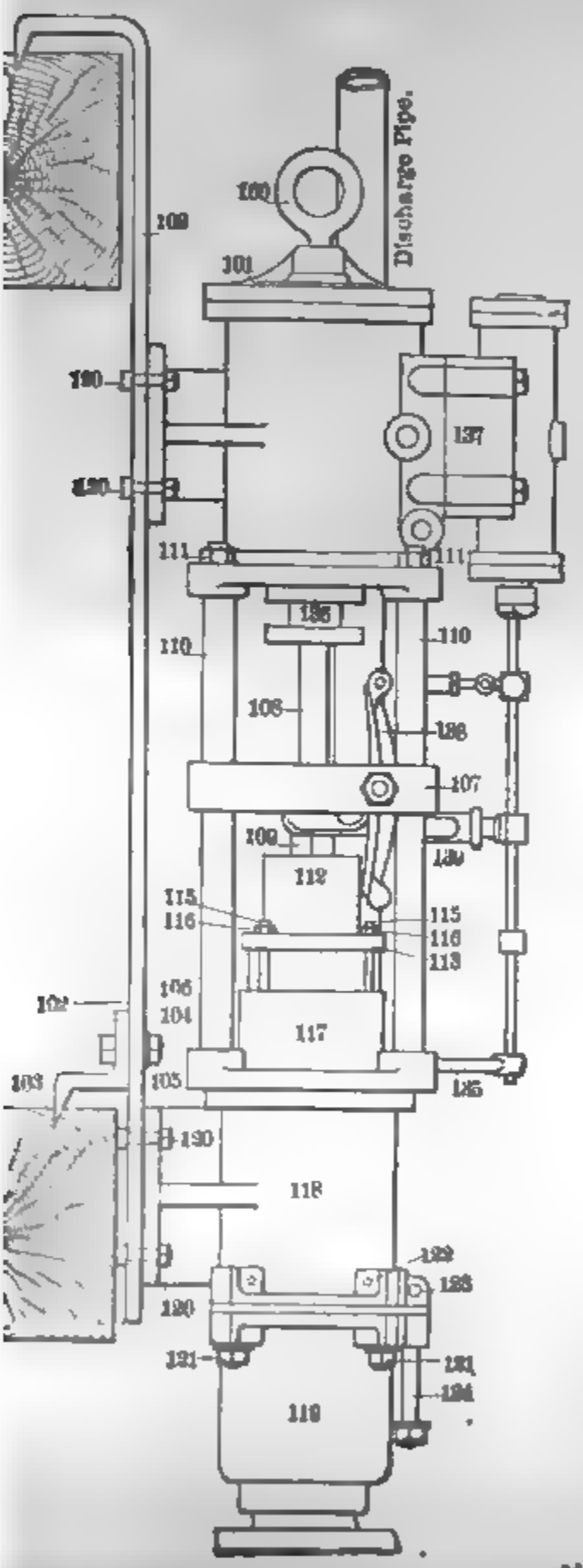
NUMBERED LIST OF PARTS OF SPECIAL DUPLEX PUMPS, 900 PATTERN.

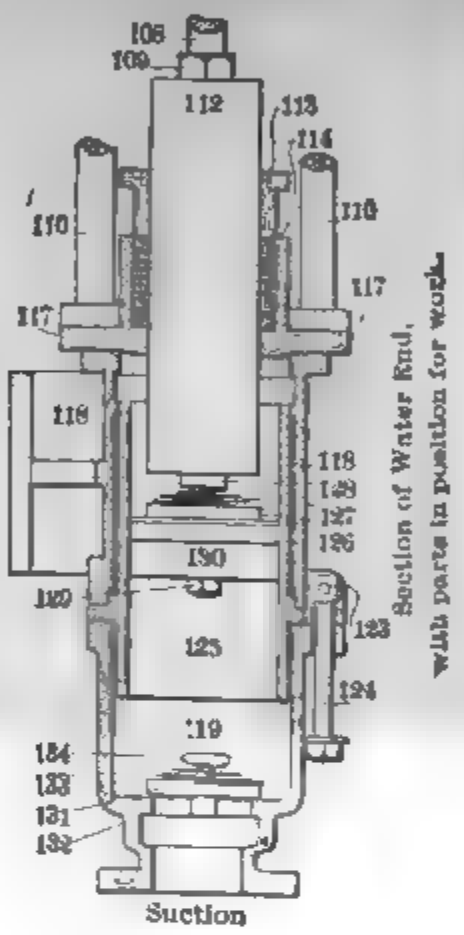
(For names of parts see opposite page.)

NAMES OF PARTS OF SPECIAL DUPLEX PUMPS, 1900 PATTERN.
(PISTON AND CENTRE PACKED PLUNGER TYPES.)

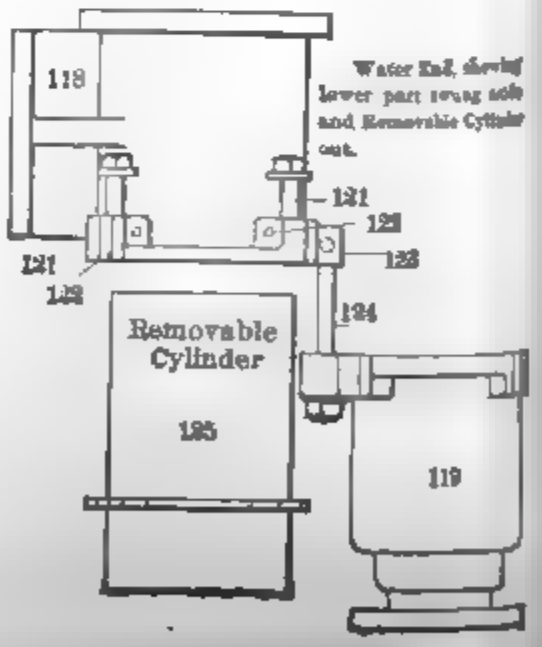
No.	NAME OF PART.	No.	NAME OF PART.	No.	NAME OF PART.
1	Steam Cylinder Head.	19	Long Lever.	37	Suction Flange.
2	Steam Cylinders and Centre (cast in one piece).	20	Short Lever.	38	Discharge Flange.
3	Valve Rod Nut.	21	Lever Taper Pin.	39	Piston Rod Nut, Steam End.
4	Valve Rod.	22	R. H. Crank and Shaft.	40	Piston Rod Nut, Pump End.
5	Valve Rod Gland.	23	L. H. Crank and Shaft.	41	Water Piston Check Nut.
6	Valve Rod Knuckle.	24	Spool.	42	Pump Cylinder Foot.
7	Steam Chest.	25	Spool Set Screw.	43	Drain Plug.
8	Steam Chest Cover.	26	Pedestal.	44	Pump Piston Body.
9	Steam Piston Rings.	27	Steam Slide Valve.	45	Pump Piston Follower.
10	Steam Piston Body.	28	Pump Cylinders.	46	Pump Piston Packing.
11	Piston Rod Gland.	29	Outside Pump Head.	47	Valve Plate.
12	Steam Cylinder Foot.	30	Plunger.	48	Plunger Gland.
13	Exhaust Flange.	31	Pump Cylinder Lining.	49	Plunger Keeper.
14	Steam Flange.	32	Pump Cylinder Cap.	50	Keeper Bolt.
15	Throat Bushing.	33	Valve Bolt.	51	Plunger Gland Bolt.
16	Piston Rod.	34	Valve Spring.	52	Air Cocks.
17	Valve Rod Knuckle Pin.	35	Valve.	53	Drip Cocks.
18	Valve Rod Link.	36	Valve Seat.	54	Valve Backing.

NUMBERED LIST OF PARTS OF KNOWLES SINKING PUMPS.





KNOWLES
BUCKET-PLUNGER SINKING PUMP.



PARTS OF KNOWLES SINKING PUMPS

lustrated and numbered on the opposite page. Customers in ordering parts, to mistakes, will please state the size of their pump, and the **Manufacturers'** l **Number**, giving list of the parts desired, with their respective names or numbers. ıethod of finding **Manufacturers' Serial Number**, see page 115.

LIST OF PARTS.

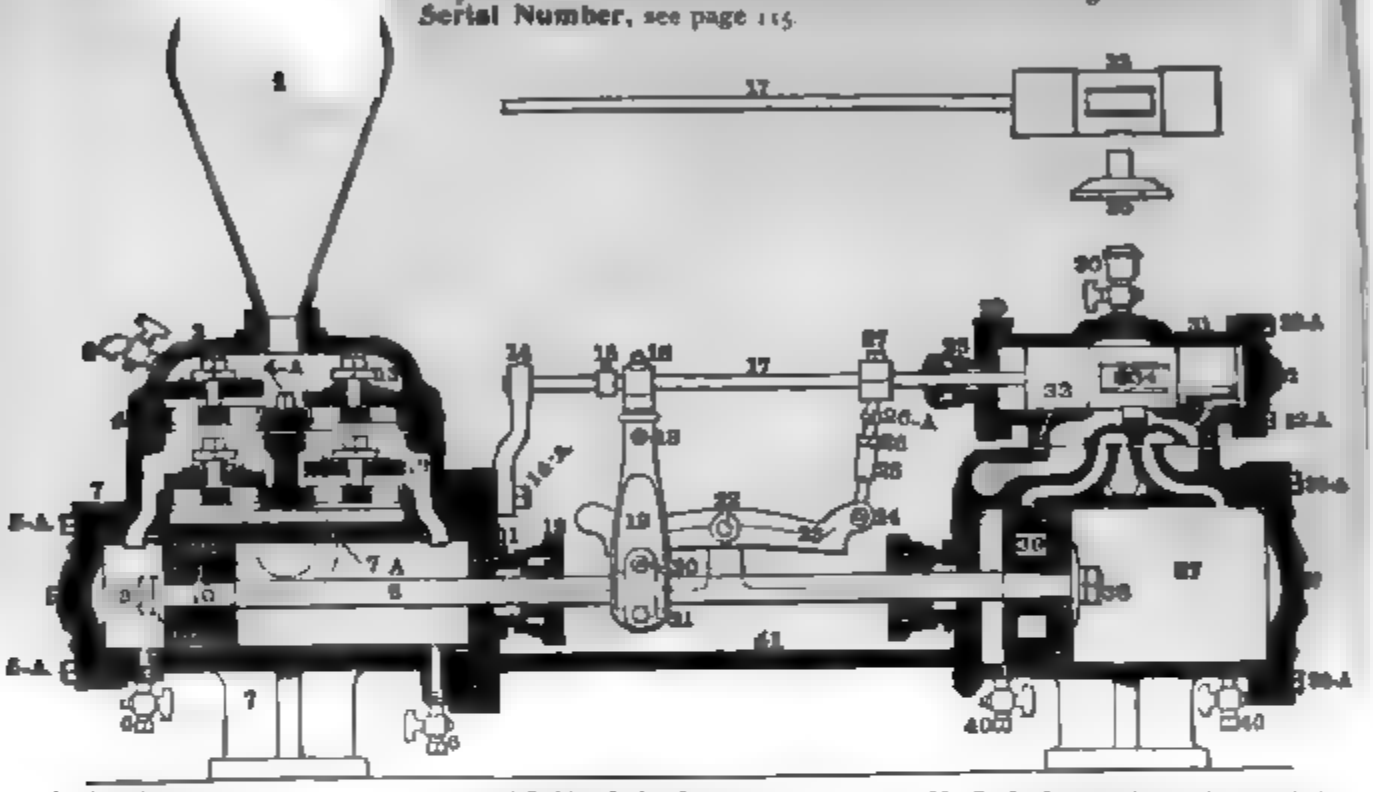
Ring Bolt.
Upper Steam Cylinder Head.
Wrought Iron Dog — main piece.
" " " — lower piece.
Bolt, for lower Wrought Iron Dog.
Nut, " " " "
Washer, " " " "
Bracket for Rocker.
Piston Rod.
" " Nut.
Tie Rod.
" " Nut.
Water Plunger.
" " Stuffing Box Gland.
" " " " Pack'g.
" " " " Bolt.
" " " " Nut.
Main Stuffing Box Casting.
Upper Water Cylinder Casting.
Lower " " "
Bolts for fastening Dogs to Pumps.
Swing Bolts with nuts and washers, for fastening upper water cyl. casting to lower water cyl. casting.

122. Hinge Pin for Lug Bolt.
123. " " " Swing-off Holding Bolt.
124. Swing-off Holding Bolt, Nut and Washer.
125. Removable Cylinder.
126. Discharge Valve.
127. " " Spring.
128. " " Bolt.
129. " " Nut.
130. Pump Bucket, forming seat of discharge valve.
131. Suction Valve.
132. " " Seat.
133. " " Spring.
134. " " Bolt.
135. Valve Rod Guide.
136. Piston Rod Stuffing Box Gland (for steam cylinder).
137. Steam Chest.
138. Rocker Bar.
139. Tappet Arm.

other parts of Pump (for Steam Cylinder, Valve Gear, etc.), see next page.

WLES SINGLE PUMPS—REGULAR PATTERN.

rs, to avoid mistakes, will please give the size of their pump, and the **Manufacturers' Serial Number**, giving list of the parts desired with their respective names or numbers. For method of finding **Manufacturers' Serial Number**, see page 115.



1 Air Chamber
2 Water Cap
2A Water Cap, Swing Bolt, complete, with Nut, Washer and Lock. Not shown in cut.
3 Air Cock
4 Valve Chamber, False Seat
4A Valve Bolt
5 Water Cylinder Head
5A Water Cylinder Head Bolt
6 Drip Cocks for Water Cylinder
7 Water Cylinder or Working Barrel including Lining and Suction Valve Seats, but no other parts.
7A Brass Lining for Water Cylinder or Working Barrel.
8 Piston Rod complete, with Nuts and Lock Nuts for both ends.
9 Piston Rod Nut and Lock Nut Water End
10 Water Piston (canvas packed) complete, embracing Head, Follower, Follower Bolts, Segments and Packing
10A Water Piston Head
10B Water Piston Follower
10C Water Piston Follower Bolt. Not in cut
10D Water Piston Packing, per ft.
10E Water Piston Segments, per set (Not in cut)
11 Piston Rod Stuffing Box complete. Same on Steam End
11A Piston Rod Stuffing Box Seat
11B Piston Rod Stuffing Box Follower
12 Piston Rod Stuffing Box Nut or Gland
13 Pump Valve, specify the kind as follows:
13A Rubber Valve, "Soft," for cold water.
13B Rubber Valve, "Hard," for hot water.
13C Rubber Valve Seat.
13D Rubber Valve Stem
13E Rubber Valve Spring
13F Metal Disk Valve, complete with Seat, Spring and Nut
13G Hinge Valve complete with Seat
13H Ball Valve, complete with Seat
13I Cage Valve, complete with Seat, Spring and Nut
13J Cage Valve Drops, each
14 Valve Rod Guide
14A Valve Rod Guide Bolt
15 Valve Rod Collar including Set Screw and Gib.
15A Valve Rod Collar Set Screw
15B Valve Rod Collar Gib.
16 Tappet Arm Tip
17 Valve Rod
18 Tappet Tip Set Screw
19 Tappet Arm complete, with Tip, Tip Set Screw and Lower Bolt and Nut
20 Rocker Roller
20A Rocker Roller Stud and Nut.
21 Tappet Arm Lower Bolt and Nut.
22 Rocker Bar Bolt and Nut
22A Rocker Bar Bolt Set Screw (not shown)
23 Rocker Bar
24 Rocker Connection Bolt and Nut
25 Rocker Connection
26 Rocker Connection Set Nut.
26A Ball Joint and Nut
27 Valve Rod Clamp, including Bolts and Gib
27A Valve Rod Clamp Bolts, each
27B Valve Rod Clamp Gib
28 Valve Rod Stuffing Box Nut or Gland
28A Valve Rod Stuffing Box Follower.
29 Back Steam Chest Head which combines the Seat for Valve Rod Stuffing Box
30 Lubricator
31 Steam Chest complete includes Heads, with their Bolts, Chest Piston and its Guide Pin, Valve Rod and its Stuffing Box, complete, Valve Rod Clamp, Bolts, and Gib, Valve Rod Collar, Set Screw and Gib, Tappet Arm Tip, Main Slide Valve Ball Joint and Nut).
31A Steam Chest, without any parts.
31B Steam Chest Holding Down Bolts, each (not shown).
32 Front Steam Chest Head
32A Front Steam Chest Head Bolts (same for back head
33 Chest Piston
34 Steam Chest Pin.
35 Main Slide Valve
36 Steam Cylinder Head.
36A Steam Cylinder Head Bolts.
37 Steam Cylinder without any parts.
38 Piston Rod Nut and Lock Nut, Steam End
39 Steam Piston complete, embracing Head, Follower, Follower Bolts, Packing Rings, Studs and Springs
39A Steam Piston Head
39B Steam Piston Packing Ring
39C Steam Piston Follower
39D Steam Piston Follower Bolts, each
39E Steam Piston Packing Studs, per set.
39F Steam Piston Packing Springs.
40 Steam Cylinder Cocks.
*41 Center Piece (casting between Steam and Water Cylinders).

Not shown in cut.

* Pumps up to No. 3, have both Steam and Water Cylinders made in one casting; No. 5, No. 4 and No. 4½ Pumps, have Steam Cylinder and center piece in one casting. In larger size Pumps, the center piece is a separate casting from both Steam or Water Cylinders.

TO CORRESPONDENTS.

IN ORDERING A PUMP, it is to the interest of the purchaser to fully inform us on the following questions:

1st. For what purpose is the pump to be used? What is the average steam pressure?

2d. What is the liquid to be pumped; and is it hot or cold, clear or gritty, fresh, salt, alkaline, or acidulous?

3d. What is the maximum quantity to be pumped per minute or hour?

4th. To what height is the liquid to be lifted by suction; and what is the length and diameter of the suction pipe, and the number of elbows or bends?

5th. To what height is the liquid to be pumped, and what is the length and size of discharge pipe?

WHEN ORDERING PARTS.

OWING to the fact of our having constructed pumps of the same size for different duties, and also on account of the improvements which we have made from time to time, during our long business career, it is ABSOLUTELY NECESSARY that all orders for parts should be accompanied with the MANUFACTURER'S SERIAL NUMBER of the pump for which said parts are required.

This number will be found stamped in some conspicuous position on every pump made by us. All direct-acting pumps, both single and duplex, have the number stamped on the edge of the *steam cylinder head*. All single pumps have it stamped on the edge of the *steam chest head*, in addition. In the case of the triplex power pumps, there is a number plate which is always placed on the frame, and the SERIAL NUMBER is also stamped on the end of the crank shaft. On single and duplex power pumps, horizontal pattern, the number is always stamped on the crank pin and on the connecting rod strap; also on the outside flange of the water cylinder head. There is also a number plate placed generally on the frame, although sometimes it is placed on the water cylinder on the inside end. On air compressors the number is stamped on the edge of the flange of the cylinder, also on the edge of the cylinder head; and there is also a number plate placed on the centre piece.

As we manufacture every part to gauge, and have a complete record of all pumps built by us, we can send correct duplicate pieces on receipt of above information. Without manufacturer's number we CANNOT duplicate parts with certainty.

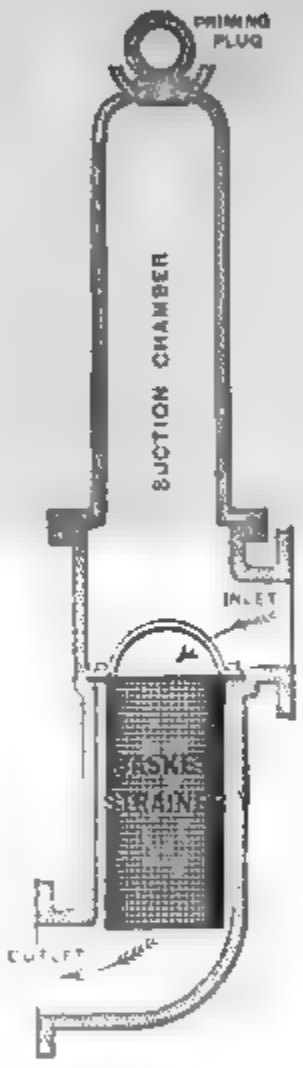
If the MANUFACTURER'S SERIAL NUMBER has become covered with rust, dirt or paint, take a file or a piece of emery cloth and rub at the point indicated above. This will bring out the MANUFACTURER'S NUMBER so that it can be easily read.

KNOWLES STEAM PUMP WORKS.

[redacted]

wles "Side Pipe and Strainer"

and Without Suction Chamber Attached.



IT IS always very desirable to place an efficient strainer on the suction pipe of a pump where there is any suspicion that the water contains dirt or sediment. We recommend the Knowles "side pipe and strainer" with or with [illegible] shown [illegible] [illegible] basket [illegible] [illegible] [illegible] rangement is a great improvement on the method commonly practiced in putting strainers on the end of the suction pipe where it is more or less inconvenient to get at to clean or repair. Should it be necessary to charge the pump with water as is often the case with long suction pipes, the priming plug shown at top of suction chamber can be easily removed. For plain strainers, see next page.

Sizes.

Size of Suction Pipe . . . Inches	2	2½	3	3½	4	5	6	8	10	12
Code Word, with Suction Chamber	a	b	c	d	e	f	g	h	i	j
Code Word, without Suction Chamber	k	l	m	n	o	p	q	r	s	t

a. Entwist
b. Envassal
c. Envenom
d. Enviable
e. Envied
f. Envious
g. Environ
h. Envoy
i. Envying
j. Enwheel
k. Eocene
l. Eolian
m. Eolipsile
n. Epanodos
o. Eparch
p. Epaulet
q. Epenetic
r. Epergne
s. Ephemera
t. Ephod

For Plain Suction Strainers, etc., see next page.

[redacted]

Check Valves and Foot Valves.

These valves are made with flanged ends, as shown, or with screwed ends, at same price. When desired, they can be made with bell and spigot ends at a slight additional cost.

Fig. 1

Fig. 2

Size . . . . . Inches	2	2½	3	3½	4	5	6	8	10	12	14	16	18	20
Check Valve, Fig. 1, Code Word	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Foot Valve, Fig. 2, Code Word	15	16	17	18	19	20	21	22	23	24	25	26	27	28

STRAINERS.

Fig. 3

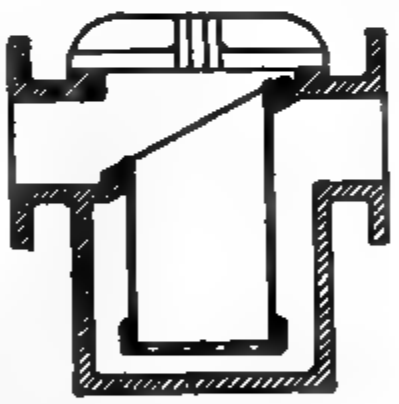


Fig. 4

Fig. 5

Sizes . . . . . Inches	2	2½	3	3½	4	5	6	8	10	12	14
Plain Strainer, Fig. 3, Code Word	29	30	31	32	33	34	35	36	37	38	39
Basket Strainer, Fig. 4, Code Word	40	41	42	43	44	45	46	47	48	49	50
Strainer and Foot Valve, combined, Fig. 5, Code Word	51	52	53	54	55	56	57	58	59	60	61

1 Epicarp
2 Epicene
3 Epicure
4 Epidemic
5 Epidemy
6 Epidictic
7 Epidote
8 Epigene
9 Epigeous
10 Epigram
11 Epigraph
12. Epilepsy
13. Epilogue
14. Epiphany
15. Epiphora
16. Epiphyte
17. Epiploce
18. Episcopy
19. Episode
20. Episodic
21. Episperm
22 Epistle
23 Epitaph
24. Epithet
25. Epitome
26. Epitrite
27. Epitrope
28. Epizoan
29. Epoch
30. Epode
31. Epulary
32 Epulose
33 Epulotic
34 Equable
35 Equant
36. Equation
37. Equator
38. Equerry
39. Equiform
40. Equine
41 Equinox
42 Equipage
43. Equipped
44. Equitant
45. Equity
46. Equivoke
47. Erasable
48 Erase
49. Erasing
50. Erasion
51. Erasure
52. Erbium
53. Erebus
54. Eremite
55. Ereption
56. Erethism
57 Ergot
58. Ergotism
59. Eridanus
60. Erinite
61. Erinnys
62. Erinyes

FOR SETTING UP AND OPERATING KNOWLES PUMPS.

IN erecting a p[illegible] ways be sure that pump is so connected as to provide a full and uniform sup[illegible]he liquid to be handled. To accomplish this result, the suction pipe should neve[illegible]s smaller than the size corresponding to the suction opening of the pump, as per table in [illegible]e catalogue. When long suction pipes are used, it is necessary to increase the diameter to [illegible] for the incre[illegible] friction The suction pipe should, accordingly, always be made as short as possible, and with as few bends as practicable, and, when convenient, use full round bends rather than elbows.

The same remarks apply to the arrangement of the discharge pipe, although not with the same force, since in the discharge pipe the full power of the pump is always available to force the liquid through the discharge piping, while in the case of the suction pipe only the atmospheric pressure is available to force the liquid into the pump.

Care should be taken in laying the suction pipe to maintain a uniform grade, so as to avoid air pockets. Where the water supply is taken from a pond, it is well to lay the suction pipe below the level of the water in the pond, if possible, all the way to the pump, and then to carry the pipe up vertically directly to the pump. In this way, most of the suction pipe will always remain full of water, and liability to air leakage is prevented Where pipe has to be laid underground, we recommend the use of cast iron flanged pipe for all sizes where it can be obtained. Use every precaution in laying pipe to prevent foreign matter, as sand or iron chips, from entering the pipe. Material of this character will quickly cut out the lining, pistons, and valves of a pump, producing serious injury The same remarks apply to the steam pipe of the pump.

The suction pipe and its connections must be perfectly air tight, as a very small leak will prevent the proper working of the pump and impair its efficiency. Before covering the suction pipe it is advisable to submit this pipe to a test pressure of about 25 lbs per square inch, to make sure that no leaks exist.

All valves in the suction and discharge piping should be gate valves.

In all cases where pump is to lift water by suction it will be found convenient to provide a priming pipe leading to the cylinders of the pump, or if suction pipe is provided with a foot valve, this priming pipe may be led to the suction box of the pump. This priming pipe may take its supply from a tank, or from the discharge pipe of the pump; being connected to the discharge pipe at a point beyond the main discharge valve An air cock is provided for the water cylinder cap, and by opening this air cock the water is allowed to fill the cylinders, displacing the air which they contain.

In admitting water to the suction box of the pump care should be taken that sufficient pressure is not developed at that point to burst any portion of the suction piping. A relief valve placed in the suction pipe will prevent any possibility of this occurring.

When the water cylinders of the pump have been filled with water, the valve in the priming pipe, and the air cock, may be closed, and the pump is then ready for starting.

[redacted]

In the case of light suction lifts the pump will readily pick up the water in the suction pipe without the above precautions being taken.

Pumps of piston pattern, owing to the facility with which packing can be renewed, and the smaller clearance spaces in the pump cylinders, are particularly efficient for lifting water by suction, where the circumstances are such that it is impossible to prime the suction piping before starting the pump.

A large suction chamber placed on the suction pipe close by the pump is very advantageous, and for pumps running at high speed is a necessity.

Care should be taken to locate the suction chamber in the continuation of the line of flow in the suction pipe, so as to relieve the pulsations in the suction pipe in the most efficient manner.

For strainers, foot valves, etc., see pages 116 and 117 of this catalogue.

Water at a high temperature cannot be raised any considerable distance by suction. For pumping very hot water place the supply high enough (or the pump low enough) so that the water will gravitate to the pump.

In connecting the steam pipe make due allowance for the expansion of the steam pipe when heated by the steam.

A throttle valve should be placed in the steam pipe as close to the pump as possible. Means should be provided for draining this pipe before starting the pump.

We recommend placing a small feed water heater in the exhaust pipe from pump; or a three-way cock may be placed in the exhaust piping and the exhaust piping connected to the suction pipe of the pump. After the pump has made a few strokes, exhausting into the atmosphere, this three-way cock may be turned and the exhaust conducted to suction, where it will be entirely condensed on coming into contact with the water flowing to the pump. See suction condenser for sinking pumps, page 33-D. In this way practically the whole of the heat used in supplying steam to operate the pump can be recovered.

Drip plugs are provided in the water end for draining the pump so as to prevent freezing.

Foundations suitable for the pump should always be provided. For a small pump an ordinary wooden floor is sufficient, but for a larger pump a small brick pier resting on the ground and provided with a cap stone is desirable.

If pump is to be stopped to be left idle for some time, fill the oil cup with oil, then open the cock from the oil cup so that this oil can flow into the steam chest; then let the pump make half a dozen quick strokes to distribute the oil well over the inside of the steam end of the pump, and so prevent danger of rusting while the pump is standing.

Keep the stuffing-boxes well packed with a good quality of packing. Don't screw the glands too tight, and don't allow the same packing to remain in the stuffing-boxes long enough to become hard and scratch the piston rod.

For boiler feeding we recommend running the pump at not more than from 30 to 40 strokes per minute when the boiler is evaporating its normal rating (30 lbs. of water per H. P. per hour).

[redacted]

:FUL INFORMATION.

STEAM.

A CUBIC inch of water evaporated under ordinary atmospheric pressure is converted into a cubic *foot* of steam (approximately).

The specific gravity of steam (at atmospheric pressure) is .421 that of air at 34° Fahrenheit, and .0006 that of water at same temperature.

37,222 cubic feet of steam weigh 1 pound; 13,817 cubic feet of air weigh 1 pound.

Locomotives average a consumption of 3000 gallons of water per 100 miles run.

The best designed boilers, well set, with good draft, [illegible]ful firing, will evaporate from 7 to 10 lbs. of water per pound of first class coal.

In calculating horse power of Tubular or Flue boilers, consider 15 square feet of heating surface equivalent to one *nominal* horse-power.

On one square foot of grate can be burned on an average from 10 to 12 lbs. of hard coal, or 18 to 20 lbs. soft coal, per hour, with natural draft. With forced draft nearly double this amount can be burned.

Steam Engines, in economy, vary from 14 to 60 lbs. of feed water and from 1⅝ to 7 lbs. of coal per hour per indicated H. P. See table below for duty of high grade engines.

Condensing engines require from 20 to 30 gallons of water, at an average low temperature, to condense the steam represented by every gallon of water evaporated in the boilers supplying engines—approximately for most engines, we say, from 1 to 1½ galls. condensing water per minute per indicated Horse Power.

Surface Condensers should have about 2 square feet of tube [cooling] surface per horse-power for a compound steam engine. Ordinary Engines will require more surface according to their economy in the use of steam. It is absolutely necessary to place air pumps below condensers to get satisfactory results.

Ratio of Vacuum to Temperature (Fahrenheit) of Feed Water.

00 inches, Vacuum ..... 212°	22½ inches, Vacuum ... 150°	28½ inches, Vacuum .... 98°
11 " " ... 190	*25 " " ... 135°	29 " " ... 72°
18 " " ... 170°	27½ " " ... 112°	29½ " " ... 58°

* Usually considered the standard point of efficiency—Condenser and Air Pump being well proportioned.

WEIGHT AND COMPARATIVE FUEL VALUE OF WOOD.

1 Cord Air dried Hickory or Hard Maple weighs about 4500 lbs., and is equal to about 2000 lbs. coal.
1 " " White Oak weighs about 3850 lbs., and is equal to about 1715 lbs. coal
1 " " Beach, Red Oak or Black Oak, weighs about 3250 lbs., and is equal to about 1450 lbs. coal.
1 Poplar (whitewood), Chestnut or Elm, weighs about 2350 lbs., and is equal to about 1050 lbs. coal.
1 Average Pine, weighs about 2000 lbs., and is equal to about 925 lbs. coal

From the above it is safe to assume that 2¼ lbs. of dry wood is equal to 1 lb. average quality of soft coal, and that the fuel value of the same *weight* of different woods is very nearly the same—that is, a pound of hickory is worth no more for fuel than a pound of pine, assuming both to be dry. It is important that the wood be dry, as each 10 per cent of water or moisture in wood will detract about 12 per cent from its value as fuel.

DUTY OF STEAM ENGINES.

A well-known engineer of high authority gives the following comparative figures showing the economy of high grade steam engines in actual practice

Type of Engine	Temperature of Feed Water.	Lbs. of Water Evaporated per lb. of Cumberland Coal.	Pounds of Steam per I. H. P. used per hour.	Pounds of Cumberland Coal used per I. H. P. per hour.	Cost per I. H. P. per hour, supposing Coal at $6.00 per ton.
Non Condensing	210°	10.5	29.	2 75	$0 0073
Condensing	120°	9 4	23.	2 12	0 0056
Compound Jacketed	120°	9 4	17	1 81	0 0045
Triple Expansion Jacketed	120°	9 4	13 6	1 44	0 0036

*** The effect of a good condenser and air pump should be to make available about 10 lbs. more mean effective pressure, with the same terminal pressure, or to give the same mean effective pressure with a correspondingly less terminal pressure. When the load on the engine requires 20 lbs. M. E. P., the condenser does half the work, at 30 lbs., one-third of the work, at 40 lbs., one-fourth, and so on. It is safe to assume that practically the condenser will save from one-fourth to one-third of the fuel, and it can be applied to any engine, *cut-off or throttling*, where a sufficient supply of water is available. See pages 54 and 55, giving illustration and description of Knowles Improved Air Pump and Condenser.

USEFUL INFORMATION—WATER.

Doubling the diameter of a pipe increases its capacity four times. Friction of liquids in pipes increases as the square of the velocity. See table of "Friction of Water in Pipes," on page 102.

The mean pressure of the atmosphere is usually estimated at 14.7 lbs. per square inch, so that with a perfect vacuum it will sustain a column of mercury 29.9 inches or a column of water 33.9 feet high, at sea level.

To find the pressure in pounds per square inch of a column of water, multiply the height of the column in feet by .434. Approximately, we say that every foot elevation is equal to ½ lb. pressure per square inch; this allows for ordinary friction.

To find the diameter of a pump cylinder to move a given quantity of water per minute (100 feet of piston being the standard of speed), divide the number of gallons by 4, then extract the square root, and the product will be the diameter in inches of the pump cylinder.

To find quantity of water elevated in one minute running at 100 feet of piston speed per minute. Square the diameter of the water cylinder in inches and multiply by 4. Example: Capacity of a 5-inch cylinder is desired. The square of the diameter (5 inches) is 25, which, multiplied by 4, gives 100, the number of gallons per minute (approximately).

To find the horse power necessary to elevate water to a given height, multiply the weight of the water elevated per minute in lbs. by the height in feet, and divide the product by 33,000 (an allowance should be added for water friction, and a further allowance for loss in steam cylinder, say from 20 to 30 per cent.)

The area of the Steam Piston, multiplied by the steam pressure, gives the total amount of pressure that can be exerted. *The area of the water piston*, multiplied by the pressure of water per square inch, gives the resistance. *A margin* must be made between the *power* and the *resistance* to *move* the pistons at the required speed — say from 20 to 40 per cent, according to speed and other conditions.

To find the capacity of a cylinder in gallons. Multiplying the area in inches by the length of stroke in inches will give the total number of cubic inches; divide this amount by 231 (which is the cubical contents of a U. S. gallon in inches), and product is the capacity in gallons.

WEIGHT AND CAPACITY OF DIFFERENT STANDARD GALLONS OF WATER.

	Cubic Inches in a Gallon.	Weight of a Gallon in pounds.	Gallons in a Cubic Foot.	Weight of a cubic foot of water, English standard, 62.321 lbs. Avoirdupois.
Imperial or English.....	277.274	10.00	6.232102	
United States	231.	8.33112	7.480519	

Weight of Crude Petroleum, 6⅓ lbs. per U. S. gallon, } 42 gallons to the barrel.
Weight of Refined " 6⅔ lbs. per U. S. gallon, }

A "miner's inch" of water is approximately equal to a supply of 12 U. S. gallons per minute.

FIRE STREAMS.

Pressures required at nozzle and at pump, with quantity and pressure of water necessary to throw water various distances through different sized nozzles — using 2½ inch rubber hose and smooth nozzles.

G. A. Ellis, C.E.

Size of Nozzles.	1 Inch.				1⅛ Inch.				1¼ Inch.				1⅜ Inch.			
Pressure at Nozzle	40	60	80	100	40	60	80	100	40	60	80	100	40	60	80	100
*Pressure at Pump or hydrant with 100 ft. 2½-in. rubber hose . .	48	73	97	121	54	81	108	135	61	92	123	154	71	107	144	180
Gallons per minute	153	189	219	245	196	240	277	310	242	297	342	383	293	358	413	461
Horizontal distance thrown	109	142	168	186	113	148	175	193	118	156	186	207	124	166	200	224
Vertical dist. thrown	79	108	132	148	82	112	137	157	82	115	140	164	85	118	146	169

* For greater lengths of 2½ hose the increased friction can readily be obtained by noting the difference between the above given "pressure at nozzle" and "pressure at pump or hydrant with 100 *feet* of hose." For instance, if it requires at hydrant or pump 61 lbs. more pressure than it does at nozzle to overcome the friction when pumping through 100 feet of 2½ inch hose (using 1 inch nozzle, with 40 lb. pressure at said nozzle), then it requires 16 lbs. pressure to overcome the friction in forcing through 100 feet of same size hose.

FRICTION OF WATER IN PIPES.

re per square inch, for each 100 feet of length in different size clean Iron Pipes discharging given quantities of water per minute. G. A. Ellis, C.E.

	SIZES OF PIPES—INSIDE DIAMETER.														
	[In.	1 In.	1¼	n.	2 In.	2½ In	3 In.	4 In.	6 In.	8 In.	10 In.	12 In.	14 In.	16 In	18 In.
5	3.3	0.84	0												
10	13.0	3.16	1		0.12	..	..								
15	28 7	6.98	2		..		..								
20	50 4	12.3	4		0.42			..							
25	78 0	19.0	6.40		..	0.21	0.10								
30		27 5	9.15		0.91										
35		37 0	12.4												
40		48.0	16.1		1.60	..	.20								
45	..		20.2	8.15											
50			24.9	10.0	3 44	0 81	0.35	0.09							
75		..	56.1	22.4	5.32	1.80	0.74	0.23							
100				39.0	9 46	3 20	1 31	0.33	0.05	..					
125					14.9	4 89	1.99								
150					21 2	7.0	2.85	0.69	0.10						
175					28.1	9.46	3.85								
200					37 5	12.47	5.02	1 22	0.17						
250						19.66	7.76	1 89	0.26	0.07	0.03	0.01			
300						28.06	11.2	2.66	0.37	0.09	0.04				
350							15.2	3.65	0.50	0.12	0.05	0.02			
400							19.5	4.73	0.65	0.16	0.06				
450							25.0	6.01	0.81	0.20	0.07	0.03			
500							30.8	7 43	0 96	0 25	0.09	0.04	0. 17	0 009	0.205
750									2 21	0. 53	0 18	0.08			
1000									3 88	0 94	0.32	0 13	0.062	0 036	0 020
1250	..									1 46	0.49	0.20	..		
1500										2 09	0 71	0 29	0.135	0 071	0 040
1750											0 95	0 38			
2000											1 23	0.49	0.234	0 123	0 071
2250												0.63			
2500												0.77	0 362	0 188	0 107
3000												1 11	0 515	0. 267	0 150
3500													0.697	0 365	0 204
4000													0 910	0 472	0 263
4500														0 593	0 333
5000														0 730	0.408

AREAS OF CIRCLES.

Diam	Area.	Diam	Area	Diam	Area.	Diam	Area.	Diam.	Area.	Diam.	Area.	Diam.	Area.
⅛	.0122	4 in	12 56	13 in	132 73	2 in	380 13	36 in.	754 7	40 in.	1256 6	49 in	1885 7
¼	049	⅓	13 20	½	143 13	½	397 60	⅓	770 3	⅓	1288 2	½	1924 4
⅜	110	5 in.	19 63	14 in.	153 94	21 in	415 47	32 in	804 2	41 in.	1320 2	50 in.	1963 5
½	196	½	24 54	½	165 13	½	433 73	½	829 5	½	1352 6	½	2002 9
⅝	441	6 in	28 27	15 in.	176 71	22 in	452 39	33 in	855 3	42 in.	1385 4	51 in	2042 8
¾ in	785	⅓	33 18	½	189 69	½	471 43	½	881 4	½	1418 6	½	2083.0
⅞	994	7 in.	38 48	16 in	201 06	23 in	490 8	34 in.	907 9	43 in.	1452 2	52 in	2123.7
1	1 227	½	44 17	½	213.82	½	510.7	⅓	934 8	½	1486 1	½	2164.7
⅛	1 767	8 in	50 26	17 in.	226.98	24 in	530 9	35 in.	962 1	44 in.	1520 5	53 in	2206 1
¼	2.405	½	56 74	½	240.52	½	551 5	⅔	989 8	½	1555 2	½	2248.0
2 in.	3 141	9 in	63 61	18 in	254 46	25 in	572 5	36 in.	1017 8	45 in.	1590 4	54 in	2290.2
⅛	3.976	½	70 88	½	268 80	½	593 9	⅔	1046 3	½	1625 9	½	2332.8
¼	4 908	10 in	78 54	19 in.	283 53	28 in	615 7	37 in.	1075.2	46 in.	1661 9	55 in.	2375 8
⅜	5.939	½	86 59	½	298 64	½	637 9	½	1104 4	½	1698 2	½	2419.2
3 in.	7 06	11 in	95.03	20 in	314 16	29 in	660.5	38 in.	1134.1	47 in.	1734 9	56 in	2463 0
⅛	8.29	⅝	103 87	½	330 16	⅔	683.4	½	1164.1	½	1772 0	½	2507 1
¼	9.62	12 in.	113 10	21 in	346. 36	30 in	706.8	39 in.	1194 6	48 in.	1808 5	57 in	2551 7
⅜	11 04	½	122.71	½	363 05	½	730.6	½	1225.4	½	1847.4	½	2596.7

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RAL TELEGRAPHIC CODE.

DE, AI CODE, OR LIEBER'S CODE ALSO USED.

Cable Address—"Dogmatic" New York.

NERAL CORRESPONDENCE.

lings.	telegram of to-day.
on.	telegram of yesterday
poned.	telegram of day before
Weaponless.	Refer[illegible]
Weaponry	Referring
Wearable.	Referring
Wearied	Referring [illegible]
Wearful.	Refe[illegible]
Wearifully	Refe[illegible]
Weariless	The [illegible] number of the [illegible] t word as a numeral [illegible])
Weasand.	The manufactu[illegible]ial number of the pump is
Weatherly	What is the manufacturers' serial number of the pump?
Weathers.	State steam pressure.
Weazen.	State water pressure
Webbies.	State capacity required in U. S. gallons per minute.
Webby	State capacity required in U. S. gallons per twenty-four hours
Webeart	This represents the maximum service that will be required of the pump the ordinary service is considerably less severe
Webekeller.	Is pump to be simple, compound, triple expansion, condensing, non condensing or power driven?
Webekunst.	What is the maximum temperature of injection water?
Webeleinen.	Cannot fulfill conditions named with pump of size specified. Would recommend the following
Webenest.	Full particulars will be sent by mail.
Weberbaum.	Answer by mail.
Weberkarde	Answer by telegraph.
Weberlade.	Will write you fully to-day
Weberlied.	Will write you fully in a day or two.
Weberlohn	Please give us weight of heaviest piece (or weight of heaviest piece is
Webersmann.	Please give us size of largest piece or size of largest piece is).
Webervogel.	Telegraph what pump you recommend as best fitted to the following conditions of service
Weberzange	What H. P. boiler is necessary to run pump under the stated conditions?
Webestoff.	——H. P. boiler is necessary to run pump under the stated conditions.
Webewerk.	When will you be at
Webster.	When will you leave?
Websterite	What will be your next address?
Webstuhl.	What do you advise?
Wechselrad.	Send blue print by first mail.
Weckenales.	Await correct drawing.
Weckendes.	Send blue print for order —— by first mail.
Weckeruhr.	As per Knowles general catalogue edition of 1898, page
Weckerund.	As per Knowles general catalogue, edition of 1902, page
Weckruf.	As per Knowles catalogue of electrically operated power pumps, page ——
Wedded	As per Knowles catalogue of paper-makers' power pumps, page——
Wedderij	As per Knowles catalogue of mining pumps, page ——
Weddings.	As per Knowles catalogue of air pumps and condensers, page ——
Wedel.	As per Blake general catalogue, page ——
Wedelaffe.	As per Blake general catalogue, 1900 edition, page——

PRICES AND QUOTATIONS.

Weegsteen	Telegraph price of —
Weekachtig	Telegraph price and weight of —
Weekbeen.	Telegraph price and weight of ——and how soon you can ship.
Weekbeenig.	Telegraph price of —— and how soon you can ship.
Weekbeurt.	Telegraph price of pump to perform the following service, and confirm quotation by mail with full particulars
Weekbladen	Telegraph size, price, weight, and time in which you can deliver a pump to perform the following service
Weekdieren.	Send us by mail size, price, weight, and time in which you can deliver a pump to perform the following service —
Weekgeld.	Telegraph price, weight, and time in which you can deliver a pump to perform the following service —
Weekhartig.	Telegraph price and weight of pump to perform the following service —
Weekheid.	Telegraph size and price of pump to perform the following service —
Weeklacht.	Prices quoted are net.
Weekloon.	Prices quoted are subject to the usual discount
Weekmarkt.	Prices quoted are subject to—— per cent. discount.
Weeksteen	Price is for pump alone with no extras.
Weeldebron.	Price includes all fittings and fixtures called for in specification.
Weeldehof.	Price is net for delivery f. o. b. cars at factory.
Weelderig.	Price is net, and includes boxing for export and delivering f. o. b. steamer at New York.
Weemoed.	Price is net, and includes boxing for export and delivering f. o. b. steamer at Boston.
Weemoedig.	Our only terms are cash on presentation of bill of lading.
Weenend.	Our only terms are cash with order

[redacted]

ORDERING.

Weevilled.	Enter our order for the following and ship to us here immediately.
Weltage.	Enter our order for the following and ship to us at_____
Wegaetzen.	Enter our order for the following and ship to_____at_____
Weganlage.	Enter our order for the following and hold for shipping instructions.
Wegbannen.	Duplicate order No._____
Wegbegeben.	Duplicate order No._____twice.
Wegbeizen.	Duplicate order No._____three times.
Wegbikken.	Ship as early as possible one pump as per our order_____
Wegblazen.	Ship as early as possible two pumps as per our order_____
Wegblicken.	Please add the following to our order____
Wegbuigen.	Ship us at once following parts as per page____of Knowles general catalogue.
Wegdooien.	Ship us at once following parts as per page____of Blake general catalogue.
Wegdruipen.	Order will be canceled if not shipped within time specified.
Wegdweilen.	Cancel our order.
Wegeamt.	Too late to cancel order.
Wegeamtes.	Accept order on conditions named.
Wegebau.	We cannot accept the order on the conditions specified.
Wegedistel.	Suspend work on order_____till you receive further instructions.
Wegedoorn.	Have entered your order and will ship_
Wegelerche.	Order_____is now ready and will leave by first steamer.
Wegelos.	Order_____has been detained in consequence of defect being discovered.
Wegeloser.	Order_____is ready for shipment, but we cannot secure freight room on steamer about leaving. Will ship by first opportunity.
Wegemesser.	The order is urgent, give it special attention.

TIME OF DELIVERY.

Weggesnapt.	Delivery in one day after receipt of order.
Weggesneld	Delivery in two days after receipt of order.
Weggetrapt.	Delivery in three days after receipt of order.
Weggevijld.	Delivery in four days after receipt of order.
Weggewaaid.	Delivery in five days after receipt of order.
Weggezakt.	Delivery in six days after receipt of order.
Weggezeild.	Delivery in seven days after receipt of order.
Weggezet.	Delivery in eight days after receipt of order.
Weggleiten.	Delivery in nine days after receipt of order.
Weghakken.	Delivery in ten days after receipt of order.
Weghanken.	Delivery in eleven days after receipt of order.
Weghoebest.	Delivery in twelve days after receipt of order.
Wegholen.	Delivery in one week after receipt of order.
Weghuepfen.	Delivery in two weeks after receipt of order.
Weghuschen.	Delivery in three weeks after receipt of order.
Wegjagen.	Delivery in four weeks after receipt of order.
Wegkapen.	Delivery in five weeks after receipt of order.
Wegkehren.	Delivery in six weeks after receipt of order.
Wegknagen.	Delivery in seven weeks after receipt of order.
Wegknijpen.	Delivery in eight weeks after receipt of order.
Wegkruien.	Delivery in nine weeks after receipt of order.
Wegkwijnen.	Delivery in ten weeks after receipt of order
Weglachen.	Delivery in one month after receipt of order.
Weglagern	Delivery in two months after receipt of order.
Weglating.	Delivery in three months after receipt of order.
Weglaufen.	Delivery in four months after receipt of order.
Weglehnen.	Delivery in five months after receipt of order.
Weglenken.	Delivery in six months after receipt of order.
Wegleugnen.	Delivery in seven months after receipt of order.
Wegmeter.	Delivery in eight months after receipt of order.
Wegnehmen.	Delivery in nine months after receipt of order.
Wegneming.	Delivery in ten months after receipt of order.
Wegpaschen.	Delivery in eleven months after receipt of order.
Wegpflanze.	Delivery in twelve months after receipt of order.

SHIPPING.

Wegsterben.	Ship by freight.
Wegsteuer.	Ship by fast freight this day without fail.
Wegstossen.	Ship by all-rail route.
Wegstrich.	Ship by express.
Wegstunde.	Ship by express to-day without fail.
Wegtilgen.	Ship by steamer.
Wegtrappen.	Ship by sailing vessel.
Wegvallen.	Ship by cheapest route.
Wegvloeien.	How soon can you ship?
Wegvoeren.	When did you ship?
Wegvreten.	When can you ship our order No.____

SHIPPING — CONTINUED.

'egwaelzen.	___ will be shipped.
'egwart.	___ was shipped.
'egwarten.	___ on steamer ___
'egweiser.	W ___ bills of lading were for ___
'egwerker.	Have y ready for immediate shipment?
'egzaubern.	We have in stock ready for immediate shipment.
'egzenden.	Order No. must be shipped by ___
'egzetten.	Order No ___ will be canceled unless shipped by ___
'egzwemmen.	Order will be canceled if not shipped within time specified.
'ehgeheul.	Give our order ___ special attention, and telegraph us when you will ship. Hurry this. Important.
Wehlaut.	Ship and draw with bill of lading attached.
Wehmuethig.	By what route did you ship?
Wehrbinde.	Telegraph car number
Wehrloser	Shall we ship all rail?
Wehrmann.	If you cannot ship at once, telegraph us.
Wehrthurm.	Send tracer immediately after shipment of ___
Wehruf.	Unable to ship, as promised, pump on your order ___ Will forward ___
Wehrzoll.	We expect to ship
Wehthat.	Telegraph shipping instructions for your order ___
Wehvoll.	Prepay freight.

TYPES OF PUMPS.

eidehour	State type of pump.
'eideloch.	Pump to be of the vertical type.
'eidenbaum.	Pump to be of the horizontal type.
'eidenhahn.	Pump to be of piston pattern
'eidenholz.	Pump to be of the removable cylinder pattern.
'eidenimf.	Pump to be of the inside plunger pattern.
'eidenkorb.	Pump to be of the double plunger pattern (outside packed plungers)
'eidenlohe.	Pump to be of the solid cylinder outside plunger pattern, with valve caps bolted on.
'eidepacht.	Pump to be of the pot valve outside packed plunger pattern.
'eidepad.	Pump to be of the central packed outside plunger pattern
eidepferd.	Horizontal single boiler feed, or pressure pump
eideplatz	Horizontal single tank, or light service pump
eiderecht	Pump to be of the single type
'eidevieh.	Pump to be of the single compound type
'eidewinde.	Pump to be of the single triple compound condensing type.
'eidgang	Special duplex pump.
'eidgesell.	Pump to be of the duplex type.
'eidlust.	Pump to be of the compound duplex type
'eidmann.	Pump to be of the compound, duplex type, with low pressure cylinders located between high pressure cylinders and water cylinders.
'eidmesser.	Pump to be of the compound, duplex type, with high pressure cylinders located between low pressure cylinders and water cylinders.
'eidmuehle.	Pump to be of the triple compound duplex condensing type.
eidsaecke	Pump to be compound duplex condensing
eidwort.	Pump to be compound duplex non-condensing
e dwund.	Pump to be of the fly-wheel type.
eifelen.	Pump and boiler combined.
eifeling.	Pump and boiler mounted on wheels.
eifenstab.	Vertical duplex pump.
[illegible]	[illegible]tical simplex boiler feed pump.
[illegible]	[illegible]tical simplex light service pump.
Weighable	Automatic feed pump and receiver with receiver placed alongside of pump
Weighting	Automatic feed pump and receiver with the receiver placed above the pump.
Weighty	Single power pump, belted, no gears
Weigrond.	Single power pump, belted, with gears
Weihaltar	Pump to be of the duplex belted type, without intermediate gears
Weihbecken.	Pump to be of the duplex belted type, with intermediate gears connecting pulley shaft to crank shaft
Weihéa.	Pump to be of the duplex power driven type, fitted with gear and pinion, and with pinion shaft extended ready to receive coupling, but without any pulley
Weihebrot.	Pump to be of the horizontal, triplex, belted type.
Weihekranz.	Pump to be of the horizontal triplex type, arranged with extended bed plate to receive motor, including all gearing.
Weihelied.	Pump to be of the vertical, triplex, belted type.
Weihenfuss.	Pump to be of the vertical, triplex type, arranged with extended bed plate to receive motor, including all gearing.
Weihetafel.	Pump to be arranged for driving by belt, and no gears to be furnished.
Weihetanz.	Direct acting blowing engine.
Weihevoll.	Single fly-wheel air compressor.
Weihgesang.	Duplex fly-wheel air compressor
Weihlicht.	Belt driven single air compressor.
Weikaas.	Belt driven duplex air compressor.
Weilanden.	Sinking pump, bucket and plunger pattern
Weinapfel.	Sinking pump, central packed outside plunger pattern.
Weinart.	Sinking pump, Palmer type, two steam cylinders tandem
Weinbalsam.	Horizontal air pump and jet condenser.
Weinbann.	Combined air and circulating pump
Weinbecher.	Combined air and boiler feed pu
Weinbeere.	Marine air pump, horizontal pat
Weinbeleit	Feath[illegible]

TYPES OF PUMPS — CONTINUED.

Weinbergen. Vertical double acting marine air pump.
Weinblume. Horizontal circulating or wrecking pump.
Weinfarbe. Vertical wrecking pump.
Weinfleck. Vertical irrigating pump.
Weinfreund. Vacuum pump.
Weinfrohne. Fly-wheel vacuum pump, single type.
Weingalle. Duplex fly-wheel vacuum pump.
Weingegend. Combined vacuum and water pump.
Weingehalt. Duplex hydraulic pump.
Weingeruch. Single hydraulic pump.
Weinguelte Low pressure pump.
Weinhahn. Pump to be of the vertical beam pattern, with one steam cylinder, and two single acting pump cylinders.
Weinhandel. Pump to be of the vertical twin pattern, with two steam cylinders, and with two single acting pump cylinders.
Weinhitze. Pump to be of the vertical twin pattern, with two steam cylinders, and with two double acting pump cylinders.
Weinhoehe. Pump to be of the vertical twin combined air and circulating type, with single acting air cylinder and double acting circulating cylinder, and two steam cylinders.
Weinholz. Pump to be of the vertical, twin, combined air and circulating type, with two steam cylinders, and both pump cylinders single acting.
Weinhuelse. Pump to be of the vertical, beam, combined air and circulating type, with one steam cylinder, and both pump cylinders single acting.
Weinigje. Pump to be of the vertical, beam, combined air and circulating type, with single acting air cylinder, and double acting circulating cylinder, and one steam cylinder
Weinjahr Vertical twin single-acting beam air pump, with jet condenser
Weinjahren Vertical single-acting beam air pump (one steam cylinder pattern), and jet condenser
Weinkanne. Pump to be of the vertical, twin, combined air and circulating type, with two steam cylinders, and with both pump cylinders double acting.
Weinkeller. Pump to be of the vertical, beam, combined air and circulating type, with one steam cylinder, and with both pump cylinders double acting
Weinknecht. Pump to be of the vertical, tandem, combined air and circulating type all cylinders double acting.
Weinkneden. Pump to be of the cross-compound, vertical, direct-acting type.
Weinknegar. Pump to be of the cross-compound, horizontal, direct-acting type
Weinkneipe. Pump to be of the horizontal, cross-compound, fly-wheel type.
Weinkopf. Pump to be of the horizontal, triple expansion, fly-wheel type, one high pressure cylinder on one side, one intermediate pressure cylinder on the opposite side, and two low pressure cylinders, one on each side.
Weinkoster. Pump to be of the vertical, compound, fly-wheel type, with single acting water plungers.
Weinkrampf. Pump to be of the vertical, compound, fly-wheel type, with double acting water plungers
Weinkrugar. Pump to be of the fly-wheel type with Meyer cut-off valve gear.
Weinkruges. Pump to be of the fly-wheel type with Corliss valve gear
Weinlandes Pump to be of the plain slide-valve fly wheel type
Weinlaub. Pump to be of the vertical, triple expansion, fly-wheel type, with single acting water plungers.
Weinlauben. Pump to be of the vertical, triple expansion, fly-wheel type, with double acting water plungers.
Weinlieder. Pump to be of the differential plunger type.
Weinmakler. Pump to be of the bucket and plunger type.
Weinmarkt. Pump to be same style as shown in Knowles photograph No. _
Weinmeth. Pump to be same style as shown in Blake photograph No. _
Weinmonat. Pump to be same style as shown on Knowles drawing No. _
Weinmuster. Pump to be same style as shown on Blake drawing No. _
Weinmuthig. Pump to be *exactly* as shown on Knowles drawing No. _
Weinnachen. Pump to be *exactly* as shown on Blake drawing No. _

SPECIFICATIONS.

Weissarmig. Water is clear.
Weissbalg. Water is gritty.
Weissbirke. Water is acidulous.
Weissbrot. Pump is for fresh water.
Weissbuche. Pump is for salt water.
Weissdorn. Pump is to handle water at a temperature below 120 degrees Fahr.
Weisserzen. Pump is to handle water at a temperature above 120 degrees Fahr.
Weissfuchs. Pump to handle oil.
Weissgelb. Pump to be provided with—
Weissglanz. Pump to have hard rubber valves.
Weisshafer. Pump to have soft rubber valves.
Weissite. Pump to have brass valves.
Weisskraut. Pump to be provided with ball valves of composition.
Weisskunig. Pump to be provided with ball valves of hard rubber.
Weissling. Pump to be provided with mechanically moved valves in pump end.
Weissmehl. *Pump to have brass ring packing in pump piston.*
Weissmoewe. Pump to have brass ring packing in pump piston and brass valves.
Weissroth. Pump to have brass piston rods.
Weisssauer. Pump to have brass plungers.
Weissstein. Pump to have brass glands.
Weisssud. Pump to have brass lined stuffing-boxes.
Weisstanne. Pump to be brass fitted.
Weissweine. Pump to be brass fitted and to have brass valves.
Weisswurz. Pump to be provided with brass valve plates.
Weisung. Pump to have pump end made entirely of composition metal.
Weisungen. Pump to be all iron fitted—no brass parts.
Weitab. Pump to be provided with hand power attachment.
Weitachsig. Pump to be provided with metallic packing for stuffing-boxes of steam end.
Weitaestig. Nickel-plated sight feed lubricator to be furnished.
Weitasch. Pump to have iron air chamber.

SPECIFICATIONS — CONTINUED.

	pper air chamber ber to be furnished amber included. attached boiler feed
	rided with speed gov-
	ernor to be included rovided with pressure gov-
Weltsicht	No pressure governor to be included
Weltalun.	Speed of motor to be ___ revolutions per minute
Weltsprung.	If gas power motor required.
Weltspurig	Pump to have low pressure steam cylinders steam jacketed
Weltum.	Pump to have all steam cylinders steam jacketed
Weltzinkig	To have air cylinders water jacketed
Welvat	Steam and water ends to be connected by tie rods
Welzenbau	Steam and water ends to be connected by cast iron centre piece
Weizenbrot	Pump to be provided with the Knowles valve motion
Weizenfeld	Pump to be provided with the Blake valve motion.
Weizenjahr	Pump to be provided with the simples valve motion.
Weizenkorn	Pump to be provided with the standard ___ valve motion with adjustable ___ of valve rods
Weizenland	Pump to be provided with valve motion of the same type as used on "special duplex" pumps
Weizenrost	Pump to be provided with all the extras shown in photograph.
Weizensaat	Pump to be provided with all the extras shown on drawing
Weizenteig.	Special fittings shown in the photograph not to be furnished
Wekelijks	Special fittings shown on drawing not to be furnished.
Wektam.	Automatic water pressure relief valve set at ___ lbs. pressure
Welaway.	Plain strainer like figure 3, page 117 of this catalogue
Welbegaafd	Basket strainer like figure 4 page 117 of this catalogue
Welbehagen	Strainer and foot valve combined like figure 5, page 117 of this catalogue.
Welbeklant	Side pipe and strainer
Welbemand	Check valve
Welbereid.	Foot valve
Welbevolkt.	Gate valve
Welbewerkt	Steam throttle valve.
Welbezocht.	Steam end of pump to be provided with Russia iron lagging covering steam cylinder barrels
Welche.	Steam end of pump to be provided with wood strip lagging on the steam cylinder barrels
Welcherie.	Steam end of pump to be provided with cabinet wood lagging covering entire steam end.
Welcome.	Pipe openings threaded for English standard pipe thread.
Welcomely.	Pipe openings threaded for U. S. standard pipe thread.
Welcoming	Flanges to be drilled.
Weldénies.	Flanges to be left undrilled.
Weldoen	All openings to be flanged
Weldoeners.	Companion flanges to be furnished.
Weldra	Length of stroke to be for us—
Welfare	Pump to have water cylinders___ inches diameter
Welfenthum.	Revolutions per minute.
Welfsches.	Feet piston speed per minute.
Welgaan.	Steam end alone
Welgeaard	Pump end alone.
Welgeboren	Suction lift is_____ feet.
	Diameter of suction pipe is. ___ inches
	Length of suction pipe is ___feet.
	Diameter of discharge pipe is___ inches
	Length of discharge pipe is ___ feet
	Low pressure steam pistons to have two piston rods each.
Welgezind.	Low pressure steam pistons to have one piston rod each
Welgrond.	To be arranged with open suction, suction valves opening direct to atmosphere.
Welhaast.	To be arranged with confined suction valves.
Weliger	To have poppet valves in air cylinder heads
Weligheid	To have radial air valves.
Welkend.	Pump to have_____ feet of intermediate connections complete between steam and water cylinders.
Welkender	Pump to be provided with ___ feet of wood sucker rods no pipe to be furnished
Welkheit.	Pump to be provided with ___ feet of wood sucker rods and the same length of wrought iron piping
Welkomst	Pump to be provided with ___ feet of wood sucker rods and the same length of flush joint piping
Welladay	Pump to be provided with jet condenser of the cone type
Wellbeing	Pump to be provided with jet condenser of the spray type
Wellenberg	Vacuum pump is for dry system.
Wellenoild.	Vacuum pump is for wet system.
Wellengrab.	Diameter of exhaust inlet to be —
Wellenhorn	Diameter of injection pipe to be—
Wellenkamm	Pump to have buckets of composition.
Wellentanz.	Pump to have bucket rods of composition.
Wellenthal.	Pump to have head valves on composition plates.
Wellenvoll.	Pump to have buckets and bucket rods of composition and to be provided with head valves on composition plates
Wellenzug.	Pump to be provided with head valves on iron plates.
Wellevend.	Pump to be provided with air pump and jet condenser complete
Wellness	Pump to be provided with air pump and surface condenser complete.
Wellring	Condensing apparatus not included.
Welluidend.	Horizontal automatic exhaust relief valve with flanges drilled as per catalogue.
Wellustig.	Horizontal automatic exhaust relief valve with flanges left undrilled.
Welnemen.	Vertical automatic exhaust relief valve with flanges drilled as per catalogue.

SPECIFICATIONS — CONTINUED.

Welnu	Vertical automatic exhaust relief valve with flanges left undrilled.
Welpomp.	Pump to be close boxed for export.
Welriekend.	H. P. of engine is ___
Welschkohl.	The engine is a plain, slide valve engine.
Welschland.	The engine is an automatic cut-off engine.
Welsh.	The engine is a compound engine.
Welshman.	The engine is a triple expansion engine.
Welshwoman.	The point of cut-off is ____
Welsmakend.	High pressure steam cylinder.
Weltall.	Intermediate pressure steam cylinder.
Weltalter.	Low pressure steam cylinder.
Weltangeln.	Available space is___ feet long by ___feet wide by_____feet high, in the order given (or what is).
Weltapfel.	Pump to be used as a water motor.
Weltauge.	Steam and water gauges mounted on ornamental board.
Weltblatt.	Steam, water, and vacuum gauges mounted on ornamental board.
Weltbrand.	Rectangular, six figure counter attached to pump.
Weltbuehne.	Round case, six figure counter attached to pump.
Weltdame.	Set up on purchaser's foundations without any connections.
Weltenraum.	Set up on purchaser's foundations with all connections in engine room.
Weltewig.	Competent man will be sent to oversee and assist in setting up apparatus, if desired, for his expenses and a charge per day of $ ___
Weltfahrer.	Guaranteed duty of the pump to be ___ million foot pounds per hundred pounds of coal.
Weltfrei.	Guaranteed duty of the pump to be ___ million foot pounds per thousand pounds of dry steam.
Weltfreude.	Guaranteed duty of the pump to be ___ million foot pounds per million British Thermal Units.
Weltgarten.	Guaranteed duty of the pump to be ___ pounds of dry steam per net pump horse power per hour.
Weltgegend.	Guaranteed duty of pump to be___ pounds of dry steam per indicated horse power of steam end per hour.

CAPACITIES IN U. S. GALLONS PER MINUTE.

Werkstatt,	Capacity required is	1	U. S. gal.	per min.	Weserlachs,	Capacity required is	200	U. S. gal	per min.
Werkstein,	"	"	2	"	"	Weserstrom,	"	"	220	"	"
Werksters,	"	"	3	"	"	Weshalve,	"	"	240	"	"
Werkstueck,	"	"	4	"	"	Wesleyan,	"	"	260	"	"
Werkstuhl,	"	"	5	"	"	Wespe,	"	"	280	"	"
Werktafel,	"	"	6	"	"	Wespendief,	"	"	300	"	"
Werktag,	"	"	7	"	"	Wespvlieg,	"	"	320	"	"
Werktagen,	"	"	8	"	"	Wespvormig,	"	"	340	"	"
Werktijd,	"	"	9	"	"	Westbahn,	"	"	360	"	"
Werktisch,	"	"	10	"	"	Westeinde,	"	"	380	"	"
Werkwoche,	"	"	12	"	"	Westelijk,	"	"	400	"	"
Werkwoord,	"	"	14	"	"	Westenwind,	"	"	420	"	"
Werkzange,	"	"	16	"	"	Westenzeug,	"	"	440	"	"
Wermuthoel,	"	"	18	"	"	Westergang,	"	"	460	"	"
Wernerite,	"	"	20	"	"	Westerhoek,	"	"	480	"	"
Werpanker,	"	"	25	"	"	Westerhut,	"	"	500	"	"
Werpgeweer,	"	"	30	"	"	Westerner,	"	"	550	"	"
Werpkoord,	"	"	35	"	"	Westerzon,	"	"	600	"	"
Werplans,	"	"	40	"	"	Westgothen,	"	"	650	"	"
Werpnet,	"	"	45	"	"	Westgrenze,	"	"	700	"	"
Werpriem,	"	"	50	"	"	Westhimmel,	"	"	750	"	"
Werpschijf,	"	"	55	"	"	Westkant,	"	"	800	"	"
Werpspies,	"	"	60	"	"	Westkust,	"	"	850	"	"
Werptol,	"	"	65	"	"	Westlicher,	"	"	900	"	"
Werptuig,	"	"	70	"	"	Westmeer,	"	"	950	"	"
Werthbrief,	"	"	75	"	"	Westmost,	"	"	1000	"	"
Werthen,	"	"	80	"	"	Westringie,	"	"	1100	"	"
Wertherian,	"	"	85	"	"	Westspitz,	"	"	1200	"	"
Werthtaxe,	"	"	90	"	"	Westvolkes,	"	"	1300	"	"
Werthzins,	"	"	95	"	"	Westwaarts,	"	"	1400	"	"
Wervel,	"	"	100	"	"	Westwardly,	"	"	1500	"	"
Wervelader,	"	"	110	"	"	Westwelt,	"	"	1600	"	"
Wervelbeen,	"	"	120	"	"	Westwind,	"	"	1700	"	"
Wervelen,	"	"	130	"	"	Westwinden,	"	"	1800	"	"
Wervelhaak,	"	"	140	"	"	Westzijde,	"	"	1900	"	"
Wervelwind,	"	"	150	"	"	Weswege,	"	"	2000	"	"
Wervelziek,	"	"	160	"	"	Wetbreker,	"	"	2100	"	"
Werwaarts,	"	"	170	"	"	Wetgeving,	"	"	2200	"	"
Wesenloser,	"	"	180	"	"	Wethouder,	"	"	2300	"	"
Wesenlehn,	"	"	190	"	"	Wetshod,	"	"	2400	"	"

CAPACITIES — CONTINUED.

[illegible]			2500	U. S. gal.	per min.
[illegible]			[illegible]	"	"
[illegible]	"		[illegible]	"	"
[illegible]	"	"	[illegible]	"	"
[illegible]	"	"	[illegible]	"	"
[illegible]	"	"	3000	"	"
[illegible]	"	"	3100	"	"
[illegible]	"	"	3200		
[illegible]	"	"	3300	"	"
Wetternoth,	"	"	3400		"
Wetterrad,	"	"	3500	"	"
Wetterzug,	"	"	3600	"	"
Wettfahren,	"	"	3700	"	"
Wettging,	"	"	3800	"	"
Wettjagen,	"	"	3900	"	"
Wettpreis,	"	"	4000	"	"
Wettturner	"	"	4100	"	"
Wetzfass,	"	"	4200	"	"
Wever jen	"	"	4300	"	"
Weverskam,	"	"	4400	"	"
Weverskins,	"	"	4500	"	"

Wezelbont,	Capacity required is		4600	U. S. gal.	per min.
Wezeltjes,	"	"	4700	"	"
Wezelvel	"	"	4800	"	"
Whalebone,		"	[illegible]	"	"
Whaleman,	"	"	5000	"	"
Whaling,	"	"	5500	"	"
Whallabee,	"	"	6000	"	"
Whally,	"	"	6500	"	"
Wharfage,	"	"	7000	"	"
Wharfing,	"	"	7500	"	"
Wharfinger,	"	"	8000	"	"
[illegible]ver,	"	"	8500	"	"
[illegible]ness,	"	"	9000	"	"
[illegible]st,	"	"	10000	"	"
[illegible]aten,	"	"	11000	"	"
[illegible]edled,	"	"	12000	"	"
W[illegible]edling,	"	"	13000	"	"
W[illegible]elage,	"	"	14000	"	"
W[illegible]elless,	"	"	15000	"	"
Wheelman,	"	"	——	"	"

STEAM PRESSURES.

Whereupon,	Steam pressure is		5	lbs. per	sq. in.
Wherever	"	"	10	"	"
Wherewith,	"	"	15	"	"
Wherry,	"	"	20	"	"
Whetted,	"	"	25	"	"
Whetting	"	"	30	"	"
Whey[illegible]	"	"	35	"	"
Wheyish,	"	"	40	"	"
Whichever,	"	"	45	"	"
Whiffed,	"	"	50	"	"
Whiffles	"	"	55	"	"
Whiggarchy,	"	"	60	"	"
Whiggery,	"	"	65	"	"
Whimbrel,	"	"	70	"	"
Whimling	"	"	75	"	"
Whimper	"	"	80	"	"
Whimpering,	"	"	85	"	"
Whimsey,	"	"	90	"	"
Whimsical,	"	"	95	"	"
Whinest,	"	"	100	"	"
Whiningly,	"	"	105	"	"
Whinnied,	"	"	110	"	"
Whinnying,	"	"	115	"	"

Whips,	Steam pressure is		120	lbs. per	sq. in.
Whipsters,	"	"	125	"	"
Whirlicote,	"	"	130	"	"
Whirligig,	"	"	135	"	"
Whirlpool,	"	"	140	"	"
Whirls,	"	"	145	"	"
Whirlwind,	"	"	150	"	"
Whirrick,	"	"	160	"	"
Whisk,	"	"	170	"	"
Whisked,	"	"	180	"	"
Whistles,	"	"	190		"
Whistling,	"	"	200	"	"
Whistspel,	"	"	210	"	"
Whistfisch,	"	"	220	"	"
Whiteboy,	"	"	230	"	"
Whiteflaw,	"	"	240	"	"
Whitening,	"	"	250	"	"
Whitesmith,	"	"	260	"	"
Whitespur,	"	"	270	"	"
Whitestone,	"	"	280	"	"
Whitlavies,	"	"	290	"	"
Whitleyes,	"	"	300	"	"
Whitlow,	"	"	——	"	"

WATER PRESSURES.

Whomsoever,	Total Water pressure is		5	lbs. per	sq. in.
Whoops,	"		10	"	"
Whorled,	"	"	15	"	
Whortle,	"	"	20	"	"
Whurred,	"	"	25	"	"
Wianaque,	"	"	30	"	"
Wiborada,	"	"	35		"
Wichs,	"	"	40	"	"
Wichsdose,	"	"	45	"	"
Wichsglanz,	"	"	50	"	"
Wichsleder,	"	"	55	"	
Wichtlein	"	"	60	"	"
Wickedly,	"	"	65	"	"
Wickelbaer,	"	"	70	"	"
Wickelfrau,	"	"	75	"	"
Wickelkind,	"	"	80	"	"
Wickenfeld,	"	"	85	"	"

Wickenklee,	Total Water pressure is		90	lbs. per	sq. in.
Wickered,	"	"	95	"	"
Wicleffsme,	"	"	100	"	"
Wicliffite,	"	"	110	"	"
Wicopy,	"	"	120	"	"
Wicterp,	"	"	130	"	"
Widderfell,	"	"	140	"	"
Widderhorn,	"	"	150	"	"
Widerart,	"	"	160	"	"
Widerbaum,	"	"	170	"	"
Widerbild,	"	"	180	"	"
Widerdruck,	"	"	190	"	"
Widerfahrt,	"	"	200	"	"
Widerflug,	"	"	220	"	"
Widergeist,	"	"	240	"	"
Widerglanz,	"	"	260	"	"
Widerhorst,	"	"	280	"	"

WATER PRESSURES — CONTINUED.

Widerkampf,	Total Water pressure is	300	lbs.	per	sq. in.
Widerruf,	" "	320	"	"	"
Widerspan,	" "	340	"	"	"
Widerwort,	" "	360	"	"	"
Widgeon,	" "	380	"	"	"
Widow,	" "	400	"	"	"
Widowhood,	" "	420	"	"	"
Widowly,	" "	440	"	"	"
Widriger,	" "	460	"	"	"
Wieden,	" "	480	"	"	"
Wiederrein,	" "	500	"	"	"
Wieders,	" "	550	"	"	"
Wiederwahl,	" "	600	"	"	"
Wiedijzer,	" "	650	"	"	"
Wiedmes,	" "	700	"	"	"
Wiedvolk,	" "	750	"	"	"
Wiegeband,	" "	800	"	"	"
Wiegebedje,	" "	850	"	"	"
Wiegekap,	" "	900	"	"	"
Wiegekleed,	" "	950	"	"	"
Wiegekoord,	" "	1000	"	"	"
Wiegelaken,	" "	1100	"	"	"
Wiegeln,	" "	1200	"	"	"
Wiegenbett,	" "	1300	"	"	"
Wiegenkost,	" "	1400	"	"	"
Wiegenlaut,	" "	1500	"	"	"
Wiegentuch,	" "	1600	"	"	"
Wiegepoot,	" "	17	"	"	"
Wiegetouw,	" "	1800	"	"	"
Wiegmetsje,	" "	1900	"	"	"
Wielbanden,	" "	2000	"	"	"

Wielboom,	Total Water pressure is	2200	lbs.	per	sq. in.
Wieldest,	" "	2400	"	"	"
Wieldsome,	" "	2600	"	"	"
Wielers,	" "	2800	"	"	"
Wielewaal,	" "	3000	"	"	"
Wielatok,	" "	3200	"	"	"
Wieltros,	" "	3400	"	"	"
Wienerkalk,	" "	3600	"	"	"
Wienerlack,	" "	3800	"	"	"
Wierdijk,	" "	4000	"	"	"
Wierookvat,	" "	4200	"	"	"
Wierplant,	" "	4400	"	"	"
Wiesengras,	" "	4600	"	"	"
Wiesenklee,	" "	4800	"	"	"
Wiesenkohl,	" "	5000	"	"	"
Wiesenland,	" "	6000	"	"	"
Wiesenmaus,	" "	7000	"	"	"
Wiesenraum,	" "	8000	"	"	"
Wifehood,	" "	9000	"	"	"
Wigandies,	" "	10000	"	"	"
Wigdrijver,	" "	11000	"	"	"
Wiggen,	" "	12000	"	"	"
Wiggeries,	" "	13000	"	"	"
Wighers,	" "	14000	"	"	"
Wigmaker,	" "	15000	"	"	"
Wigreve,	" "	16000	"	"	"
Wigutaart	" "	17000	"	"	"
Wihtisite,	" "	18000	"	"	"
Wihtraed,	" "	19000	"	"	"
Wijbrood,	" "	20000	"	"	"
Wijdbeens,	" "	———	"	"	"

CAPACITIES OF FREE AIR.

Wijnbouw,	Capacity	5	cu. ft. of free air	per	min
Wijnbouwer,	"	10	"	"	"
Wijndruif,	"	15	"	"	"
Wijnfleesch,	"	20	"	"	"
Wijngaard,	"	25	"	"	"
Wijngelag,	"	30	"	"	"
Wijnglazen,	"	35	"	"	"
Wijngod,	"	40	"	"	"
Wijnheuvel,	"	45	"	"	"
Wijnhuis,	"	50	"	"	"
Wijnhuizen,	"	55	"	"	"
Wijnkan,	"	60	"	"	"
Wijnkelder,	"	65	"	"	"
Wijnkelk,	"	70	"	"	"
Wijnkooper,	"	75	"	"	"
Wijnkruik,	"	80	"	"	"
Wijnmaand,	"	85	"	"	"
Wijnmoer,	"	90	"	"	"
Wijnoogst,	"	95	"	"	"
Wijnpacht,	"	100	"	"	"
Wijnpeiler,	"	120	"	"	"
Wijnpers,	"	140	"	"	"
Wijnperzik,	"	160	"	"	"
Wijnpijp,	"	180	"	"	"
Wijnplant,	"	200	"	"	"
Wijnpomp,	"	250	"	"	"
Wijnroemer,	"	300	"	"	"
Wijnsaus,	"	350	"	"	"
Wijnschaal,	"	400	"	"	"
Wijnslang,	"	450	"	"	"
Wijnsmaak,	"	500	"	"	"

Wijnsoep,	Capacity	550	cu. ft. of free air	per	min
Wijnsoort,	"	600	"	"	"
Wijnsteen,	"	650	"	"	"
Wijnsteker,	"	700	"	"	"
Wijnstok,	"	750	"	"	"
Wijntijd,	"	800	"	"	"
Wijnton,	"	850	"	"	"
Wijntros,	"	900	"	"	"
Wijnveld,	"	950	"	"	"
Wijnvlak,	"	1000	"	"	"
Wijnzak,	"	1100	"	"	"
Wijnzakke	"	1200	"	"	"
Wijselijk,	"	1300	"	"	"
Wijsgeer,	"	1400	"	"	"
Wijsgeerig,	"	1500	"	"	"
Wijsheid,	"	1600	"	"	"
Wijsneusig,	"	1700	"	"	"
Wijsvinger,	"	1800	"	"	"
Wijwater,	"	1900	"	"	"
Wijzen,	"	2000	"	"	"
Wijzerbord,	"	2200	"	"	"
Wijzertjes,	"	2400	"	"	"
Wijzigen,	"	2600	"	"	"
Wijziging,	"	2800	"	"	"
Wikgeld,	"	3000	"	"	"
Wildachtig,	"	3500	"	"	"
Wildacker,	"	4000	"	"	"
Wildbach,	"	4500	"	"	"
Wildbaches,	"	5000	"	"	"
Wildbeast,	"	———	"	"	"

(*Free air* means air measured at the atmospheric pressure.)

AIR PRESSURES.

5 lbs. per square inch.	Willekeur, Air pressure to	170 lbs. per square inch.	
10 " "	Willensakt, "	180 " "	
15 " "	Wilsbrord, "	190 " "	
20 " "	Wilsungly, "	200 " "	
25 " "	Wilsuehr, "	220 " "	
30 " "	Willowash, "	240 " "	
35 " "	Wulst, "	260 " "	
40 " "	Wilums, "	280 " "	
45 " "	Wimbling "	300 " "	
50 " "	Winnieln, "	350 " "	
60 " "	Wimmeries, "	400 " "	
70 " "	. ellijn "	450 " "	
80 " "	V elstok, "	500 " "	
90 " "	V seltjes "	600 " "	
100 " "	V perhaar, "	700 " "	
110 " "	V hies, "	800 " "	
120 " "	V hartig, "	900 " "	
130 " "	V lboort, "	1000 " "	
140 " "	V lbore., "	1500 " "	
150 " "	V lbound, "	2000 " "	
160 " "	V lbreker, "		

POUNDS OF STEAM PER HOUR.

Windhaln	50 lbs. steam per hour.	**Winlthar**	14000 lbs. steam per hour
Windhandel . . .	100 " "	**Winkel** . .	15000 " "
Windhoeble . .	150 " "	**Winkelbett** . .	16000 " "
Windhous	200 " "	**Winkelboek** . . .	17000 " "
Windhosen .	250 " "	**Winkeldach**	18000 " "
Windhosen	300 " "	**Winkeldeur** .	19000 " "
Windkant	350 " "	**Winkeldoos**	20000 " "
Windkasten	400 " "	**Winkelgeod**	22000 " "
Windkolik	450 " "	**Winkelhaak**	24000 " "
Windkunst	500 " "	**Winkeljagd**	26000 " "
Windlassed	600 " "	**Winkelknie**	28000 " "
Windlauben	700 " "	**Winkellade**	30000 " "
Windlawine	800 " "	**Winkellamp**	32000 " "
Windlehre	900 " "	**Winkelloch** . .	34000 " "
Windloser	1000 " "	**Winkelluge** .	36000 " "
Windmonat	1100 " "	**Winkelluik**	38000 " "
Windmuehle	1200 " "	**Winkelnaad**	40000 " "
Windore .	1300 " "	**Winkelraam** . .	42000 " "
Windorgel	1400 " "	**Winkeltrap** . .	44000 " "
Windowless	1500 " "	**Winkelwage** .	46000 " "
Windowry .	1600 " "	**Winkelwerk** .	48000 " "
Windpfeife .	1700 " "	**Winningly** . .	50000 " "
Windpfropf	1800 " "	**Winnkauf** . .	55000 " "
Windpipe	1900 " "	**Winnowed** .	60000 " "
Windpomp	2000 " "	**Winnowing**	65000 " "
Windrad	2500 " "	**Winselaffe** . .	70000 " "
Windrades	3000 " "	**Winterame** . .	75000 " "
Windrow	3500 " "	**Winterbier** .	80000 " "
Windrowed	4000 " "	**Winterdock** .	85000 " "
Windrowing	4500 " "	**Wintered**	90000 " "
Windsack	5000 " "	**Winterfeld** . .	95000 " "
Windstrom	5500 " "	**Winterfest**	100000 " "
Windsturm	6000 " "	**Winterhose** . .	110000 " "
Windsuppe	6500 " "	**Winterhut**	120000 " "
Windung	7000 " "	**Wintering**	130000 " "
Windungen	7500 " "	**Winterjahr**	140000 " "
Windwage	8000 " "	**Winterkorn**	150000 " "
Windwedel .	8500 " "	**Winterkuh**	160000 " "
Windwelle	9000 " "	**Winterlich** . .	170000 " "
Windzacken .	10000 " "	**Winterluft**	180000 " "
Windzak . .	11000 " "	**Winterly**	190000 " "
Windzirkel	12000 " "	**Wintermaal**	200000 " "
Wingolf	13000 " "	**Winterman**	

MAXIMUM TEMPERATURE OF INJECTION WATER.

Wintertag,	**Maximum temp. of injection water is**				**50° F.**	**Winterzon,**	**Maximum temp. of injection water is**				**75° F**
Wintertjes,	"	"	"	"	55° "	**Winthémie,**	"	"	"	"	80° "
Wintertuin,	"	"	"	"	60° "	**Wintrous,**	"	"	"	"	85° "
Winterzeit,	"	"	"	"	65° "	**Wintry,**	"	"	"	"	90° "
Winterzeug,	"	"	"	"	70° "	**Winwaer,**	"	"	"	"	—— "

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PUMPING MACHINERY

N. C.

AND

BEET SUGAR FACTORIES

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No. 484 Pag:

May 1864

Pumping Machinery

For

Beet Sugar Factories

KNOWLES STEAM PUMP WORKS

NEW YORK

CHICAGO BOSTON LONDON

1904

CATALOGUE K-104

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KNOWLES STEAM PUMP WORKS.

PREFACE.

This circular describes apparatus built in our own shops and thoroughly tested in actual service by customers throughout the world. The immense variety of our machinery enables us to supply types of pumps adapted to all the various requirements of sugar manufacture; and, for the convenience of buyers, we have here put in a concise form descriptions of the several types used in the beet-sugar industry. We not only manufacture the apparatus shown, but all other pumping machines required for any use whatever. If the customer will state the conditions involved, hearty co-operation to secure the best possible results will be extended. We are always pleased to confer with patrons concerning pumping problems and will render them valuable service in obtaining the apparatus best suited to their requirements.

We guarantee to replace without charge, within one year from shipment, any portion of our apparatus bearing evidence of imperfection in material or workmanship; and, that this Company will use its utmost endeavors to fill orders at the time promised. Beet-sugar equipments should be ordered early in the winter months while the mills are idle, in order that the latter may be properly equipped before the grinding season.

The Beet-sugar Industry.

The beet-sugar industry in this country will undoubtedly undergo extensive development during the next few years and will afford profitable investment to an immense amount of capital. It would require about 400 factories to produce the amount of beet sugar now imported annually into the United States. Of the World's sugar production not more than 40% is produced from the sugar cane, while 60% comes from sugar beets in Germany, France, Russia, Austria, Holland, Belgium, Italy, Spain, Roumania and Sweden. In Germany alone there are 420 factories. The world's production of sugar in 1900 was about 6,000,000 tons, 3,600,000 tons of which were beet-sugar. Of this, America produced 80,000 tons, which has probably been more than doubled since, as many factories have been put up.

The United States Department of Agriculture is carrying on experiments in various sections of the country in order to find the areas best suited for sugar-beet raising. In the West, many farmers have given over their land to beet culture, and it is not uncommon to realize as much as $2,000.00 profit in one season from a farm of 100 acres. The average gross receipts per acre in a number of states are as high as $54.00. Probably more than $25,000,000 is already invested in the manufacture of beet sugar in the United States. When it is stated that 500,000 tons of sugar are produced in Germany from an area only one-half as large as the State of New York, it will be seen that the possibilities of this country are almost unlimited.

For the information of those who have had no experience in this industry, we give the following brief description of the process of beet-sugar manufacture:

The beets ripen in the Fall of the year, the ripening being indicated by the leaves turning yellow. The beets are then gathered and transported to the beet sheds near the sugar factories. These sheds are connected with the

factory buildings by a trough or channel having at the bottom a long screw, and the beets are shoveled or hoed into this channel. A rapid current of water is also introduced and partially cleans the beets as they are transported by the screw to the beet washer. After being thoroughly cleansed by this machine, they are carried by an elevator to the top of the building where they are weighed by an automatic, self-dumping scale, whence they pass to the cutting machine, which slices them into strips or shreds, called "cossettes." From the cutting machines the beets are transported by a belt to the diffusion battery, which consists of a number of cells or cylinders, each capable of holding approximately three tons of sliced beets. The cylinders can be opened at the top or bottom and are connected with each other in series by piping. Water is allowed to flow into the first one and from there goes to the other cylinders, all being full of sliced beets. When the water has gone through a certain number of these cells it is sufficiently saturated with sugar to be passed to the purification process and is then known as "diffusion juice." After a brief treatment the sliced beets in the first cell are nearly free from sugar and the cell is opened and emptied. The pulp coming from it is taken away to a press and is finally transported from the factory and sold as a by-product, being largely used as feed for cattle.

The diffusion juice as it leaves the cells is black in color and carries in solution and suspension the substances which have been extracted from the beets. The extracted material consists of about 85% of sugar, together with coloring matter, albumen, organic and mineral matters and other impurities. In the process of purification, lime milk is used to precipitate the impurities. The mixture of lime milk and juice is heated and the albumen coagulated by means of carbonic-acid gas, which combines with the lime to form carbonate of lime. The fluid is then filtered, the muddy parts forming a lime cake in the filter, after which the juice is bleached by sulphur fumes and then again filtered; the result being a thin juice which is delivered to the evaporators, from which it emerges as a thick, brown liquid.

This brown liquid is again filtered and drawn off into the vacuum pans, where it is boiled until the sugar crystals form in the syrup. The sugar and syrup are separated in centrifugal machines, the crystals remaining in the centrifugals being washed with blueing in order to obtain the clear hue that is found in marketed sugar. The syrup from the centrifugals passes again through a similar process and becomes brown sugar (which is later treated into white sugar), or molasses. When the sugar leaves the centrifugals it is still wet and is transferred to the granulator where it is dried by means of heated air. After drying it is run through a sieve which retains the coarse crystals. The finished product is then placed in barrels and sacks and is ready for shipment.

This by-products of beet-sugar making comprise pulp, lime-cake, waste water and molasses. The pulp and molasses can be used for feeding stock, *such as* cattle and sheep, while the refuse lime and waste water are valuable *as fertilizers* and can be applied with advantage to the land upon which the *beet raising* is to be continued. In Germany the dried pulp sells at $18.00 to $20.00 *per ton.*

Choice of Apparatus.

The following classification will serve to indicate the types of pumps adapted to the various services encountered in a beet-sugar plant.

For **filter presses.** Single or duplex outside-packed plunger pumps.

For **sulphitors** and **evaporators.** Single or duplex tank pumps.

For **thin juice** for **sulphitors.** Single or duplex piston pumps.

For **lixivating filter presses.** Single or duplex piston pumps.

For **sulphur stove.** Direct acting blower.

For **evaporators.** Direct-acting or fly-wheel wet or dry vacuum pumps.

For **evaporator drips.** Single or duplex piston pumps.

For **battery water supply.** Single, duplex, compound or fly-wheel pumps.

For **green syrup.** Single or duplex piston pumps.

For **main water supply.** High-pressure, compound, compound condensing direct-acting, or fly-wheel pumping engines.

For **carbonic-acid gas.** Duplex or single crank and fly-wheel, positive slide-valve vacuum pumps.

For **filter-press jacks.** Single or duplex, hydraulic, direct-acting pumps.

For **boiler feed.** Single or duplex piston or plunger pumps.

For **evaporator tail pumps.** Single or duplex piston pumps.

For **pumping juice to second carbonator.** Single or duplex piston pumps.

For **pumping thin juice for second carbonator.** Single or duplex piston pumps.

For **pumping juice from first saturation receiving tank to evaporator supply tank.** Single or duplex piston pumps.

For **pumping from sulphur station receiving-tank to vacuum-pan charging tanks.** Single or duplex piston pumps.

For **pumping molasses from first floor to pan supply tank.** Single or duplex piston pumps.

For **filter-press hot-water pump.** Single or duplex piston pumps.

For **sacharate pumps.** Single or duplex outside-packed-plunger pumps.

Milk-of-lime pump. Single or duplex horizontal piston or plunger pumps.

Molasses pumps. Single or duplex piston or outside-packed-plunger pumps.

For the above services the following **alternative types** can be substituted: Vertical triplex power pumps, horizontal duplex, or single **power pumps.**

Vacuum pumps for distillation, evaporator and condenser. Direct-acting single, duplex fly-wheel, or horizontal duplex power pumps.

For **carbonic-acid gas.** Vertical triplex power, or steam driven fly-wheel, or horizontal duplex or single fly-wheel pumps.

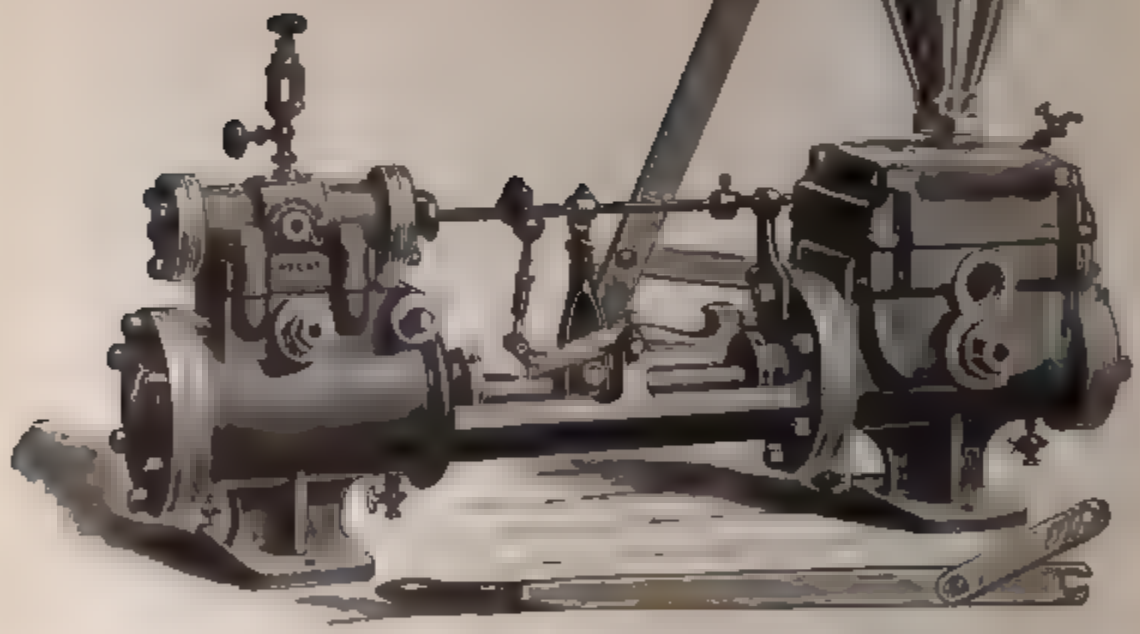
For **multiple vacuum evaporators.** Fly-wheel or direct-acting sweet-water pumps.

For **sweet water and syrup pumps.** Fly-wheel or direct-acting single, power or steam actuated pumps.

For **combined water and vacuum, combined air and circulating, combined hot and cold water, and, combined liquid and air pumps.** Pumps of direct acting or fly-wheel types.

For **moving liquids, filter service or other equipment.** Single fly-wheel or duplex air compressors.

We manufacture many types of pumping machinery which cannot be covered by *a catalogue of this kind*, and issue special catalogues describing the *different types, which will be* sent upon application.



Above cut shows No 4½ size

KNOWLES PATENT BOILER-FEED OR PRESSURE PUMP

KNOWLES PATENT

Boiler Feed or Pressure Pumps.

Arranged for Hot or Cold Water or other Liquids.

Many devices have been introduced in the market for feeding boilers, but nothing has yet proved so liable and economical as a good steam pump. The Knowles Pump has withstood the test of many ars' service, and stands to-day preeminent for its record of efficiency and durability. In its present rfected form it is the most desirable boiler feeder to be found. Its improved valve motion and steam lves secure the smoothest work under the most exacting conditions. The pump can be regulated to n at *any* speed desired—an important feature in the feeding of boilers.

In the manufacture of the Knowles Steam Pumps the best composition metal (Government standard) used for the piston rods, stuffing boxes, valve seats, and water cylinder linings. The water pistons e also made of composition, and are packed with a special form of adjustable packing, adapted for ther hot or cold liquids. All parts are made to gauge, and are therefore interchangeable.

These pumps have large direct water passages and full valve area, which admit of a speed that makes em very efficient *fire* pumps.

SIZES AND CAPACITIES.

No.	Steam Cylinder.	Water Cylinder.	Stroke.	Gallons per Stroke.	Capacity per Minute at Maximum Speed.		Steam Pipe.	Exhaust Pipe.	Suction Pipe.	Delivery Pipe.	Floor Space Required.	Telegraphic Code Word.
	Ins.	Ins.	Ins.		Strokes.	Gals.	Ins.	Ins.	Ins.	Ins.	Ins.	
o	2½	1½	3	.023	150	3½	¼	⅜	½	⅜	18 x 4	Forel
oo	3	1¾	3	.031	150	4¾	¼	⅜	¾	½	18 x 5	Forelift
0	3¼	2	4	.05	150	7½	½	¾	1¼	1	31 x 6	Forename
1	3½	2⅛	4	.07	150	10½	½	¾	1¼	1	29 x 7	Forensal
2	4	2½	5	.11	150	16½	½	¾	1¼	1	32 x 7	Forepart
3	5	3⅛	7	.25	125	31	¾	1	2	1½	44 x 10	Forerank
4	5½	3¾	7	.34	125	42	¾	1	2	1½	44 x 10	Foreread
4½	7	4	7	.39	125	49	1	1¼	2½	2	45 x 10	Forerun
5	7	4½	10	69	100	69	1	1¼	3	2½	56 x 16	Foresail
6	7½	5	10	.85	100	85	1	1¼	3	2½	56 x 16	Foresay
6½	8	5	12	1.02	100	102	1	1¼	4	4	64 x 16	Foresee
7	10	6	12	1.47	100	147	1¼	1½	4	4	68 x 19	Foreship
8	12	7	12	2.00	100	200	2	2½	5	5	68 x 19	Forest
9	14	8	12	2.61	100	261	2	2½	5	5	68 x 20	Forestay
10	16	10	16	5.44	75	408	2½	3	6	6	81 x 21	Forested

LARGER SIZES ON HAND OR TO ORDER AT SHORT NOTICE.

When ordering a pump, please answer the following questions:

1st. Whether for hot or cold water? 2d. To what height is water to be lifted by suction? 3d. Length suction pipe? 4th. Against what pressure or height is water to be forced? 5th. Amount of water eded per hour?

The Nos. o, 1, 2, 3, 4, and 4½ pumps are provided with hand power attachments.

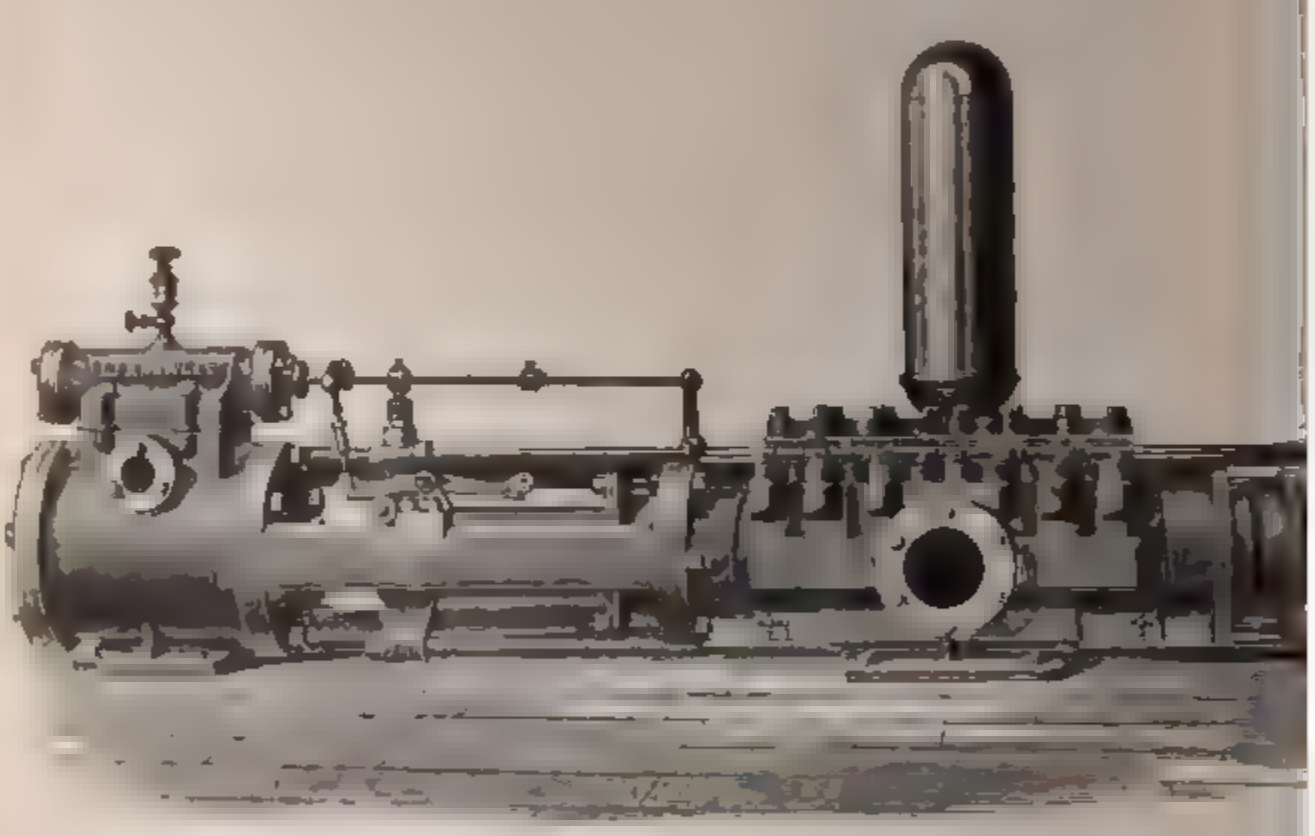
Our Patent Hand Power Attachment is invaluable, as the pump can be used, when steam is down, filling boilers after "blowing off," washing decks, fire purposes, etc. The Hand Lever can be easily noved by simply lifting it from the pump.

We do not recommend the use of copper air chambers, as experience has shown they are unreliable, ecially for pressures above 100 pounds. We will furnish copper air chambers, however, if required, sizes No. 3 to No. 10 inclusive, *at a slight* additional charge.

All sizes except No. 000 and No. 00 are good for 250 feet lift, for mine use, or for 125 pounds pressure boiler feeding. Sizes No. 000 and No. 00 are good for 100 pounds pressure.

BOILER FEED PUMP.

As per opposite page.



SPECIAL FILTER PRESS PUMP.

14x 8x12.
14x 9x18
16x10x18.
16x12x18

Special Design. Other sizes can be furnished.

KNOWLES PATENT

Plunger Pumps—Double Acting.

For Feeding Boilers, Pumping Water containing Sediment or Grit, etc.

Plunger pumps for boiler feeding, especially under the higher range of pressures, have certa advantages over "piston" pumps. They are very efficient and remarkably durable—the only weari part in the pump end being the packing of the plunger stuffing boxes. No leak can occur there witho being observed, and easily stopped by setting up the packing. The plunger not touching the pu castings, there is no cutting or wear, consequently they require no reboring or refitting, like pist pumps, when working on gritty or sandy water.

As feed pumps, where very high steam pressure is carried (300 lbs. or less), the Knowles Plung Pumps have no equal. They have a splendid record in places where the work is very severe and co tinuous, such as found in rolling mills, blast furnaces, and sugar refineries. They are also particular adapted for pumping gritty or muddy water from mines, quarries, wells, pits, and similar places.

These pumps are very strong and compact. The piston rods do not enter the pump cylinders, a are therefore not exposed to the action of the water. The plungers are connected by substantial si rods and crossheads. The water valves are of special form, made of gun metal composition or rubb according to circumstances. There is a cover over each valve, giving quick and easy access to same.

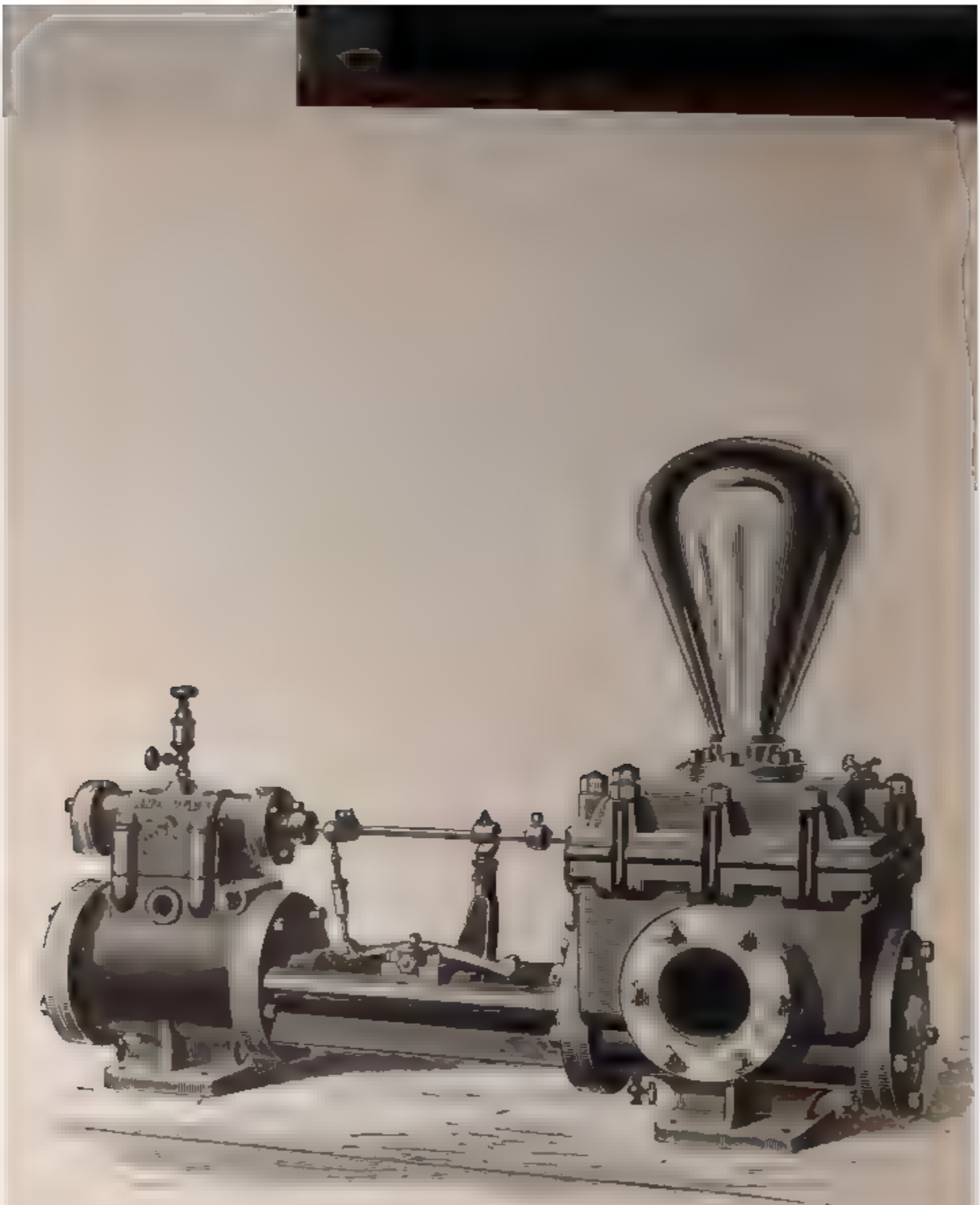
SIZES AND CAPACITIES.

Steam Cylinder	Water Plungers.	Stroke.	Gallons per Stroke.	Capacity per Minute at Maximum Speed.		Steam Pipe.	Exhaust Pipe.	Suction Pipe.	Delivery Pipe.	Floor Space Required.	Telegraphic Code Word.
Ins.	Ins.	Ins.		Strokes.	Gals.	Ins.	Ins.	Ins.	Ins.	Ins.	
4	2½	5	.11	150	16½	½	¾	1¼	1	57 x 10	Forewarn
5½	3¼	7	.25	125	31	¾	1	2	1½	72 x 12	Forewind
6	3¾	7	.33	125	42	¾	1	2	1½	72 x 12	Forewish
7½	4½	10	69	100	69	1	1¼	2½	2	92 x 12	Forfex
8	5	10	.85	100	85	1	1¼	3	2½	92 x 12	Forger
8	5	12	1.02	100	102	1	1¼	3	2½	112 x 12	Forgetful
10	6	12	1.47	100	147	1¼	1½	3½	3	112 x 22	Forgetting
12	6	12	1.47	100	147	2	2½	3½	3	114 x 22	Forgive
12	7	12	2 00	100	200	2	2½	5	4	120 x 27	Forgiving
14	7	12	2.00	100	200	2	2½	5	4	120 x 27	Forgotten
14	8	12	2 61	100	261	2	2½	5	4	124 x 27	Forkedly
16	8	12	2.61	100	261	2½	3	5	4	124 x 28	Forkhead
18	10	16	5.44	75	408	3½	4	8	6	164 x 30	Forkless

HEAVY PATTERN, FOR 300 LBS. WATER PRESSURE.

7½	3¾	10	.47	100	47	1	1¼	2	1½	92 x 12	Iberico
8	4	12	.65	100	65	1	1¼	2½	2	112 x 12	Ibexes
8	5	12	1.02	100	102	1	1¼	3	2½	112 x 12	Ibhar
10	5	12	1.02	100	102	1¼	1½	3	2½	112 x 12	Ibiapaba
10	6	12	1.47	100	147	1¼	1½	3½	3	112 x 22	Ibicara
12	6	12	1 47	100	147	2	2½	3½	3	114 x 22	Ibicencas
12	7	12	2 00	100	200	2	2½	5	4	120 x 27	Ibicinos
14	7	12	2.00	100	200	2	2½	5	4	120 x 27	Ibidion
14	8	12	2.61	100	261	2	2½	6	5	124 x 27	Ibilitaet
16	8	18	3.91	67	261	2½	3	6	5	164 x 30	Ibiracoa
16	9	18	4.96	67	330	2½	3	8	6	164 x 30	Ibiride
18	9	18	4.96	67	330	2½	3	8	6	172 x 30	Ibiscorum

All the working parts of these pumps are made to gauge, and are therefore **interchan** *Duplicate parts can be quickly substituted* when old parts are worn or broken.



KNOWLES PATENT TANK PUMP.

For Light Service.

Size, 8 x 8 x 12.

[redacted]

KNOWLES PATENT

Tank or Light Service Pumps.

pumping water or other liquids to limited heights and distances these pumps possess special ages; they combine *large pumping capacity* with small expenditure of steam. The steam cylinders, ortion to the pump cylinders, are made smaller in diameter than with the regular pressure pumps. nsequently the first cost is less—for *amount* of water pumped. These pumps are principally used oad water stations, gas and oil works, bleacheries, tanneries, refineries, plantations, distilleries, variety of valves are used adapted for pumping hot, cold, thick, thin, alkaline, or other liquids. **Quarries and Clay Pits**, also for coffer dams, tunnels, foundation pits, ore beds, sewerage, and ng purposes, these pumps are especially adapted, having large water passages and valve openings.

SIZES AND CAPACITIES.

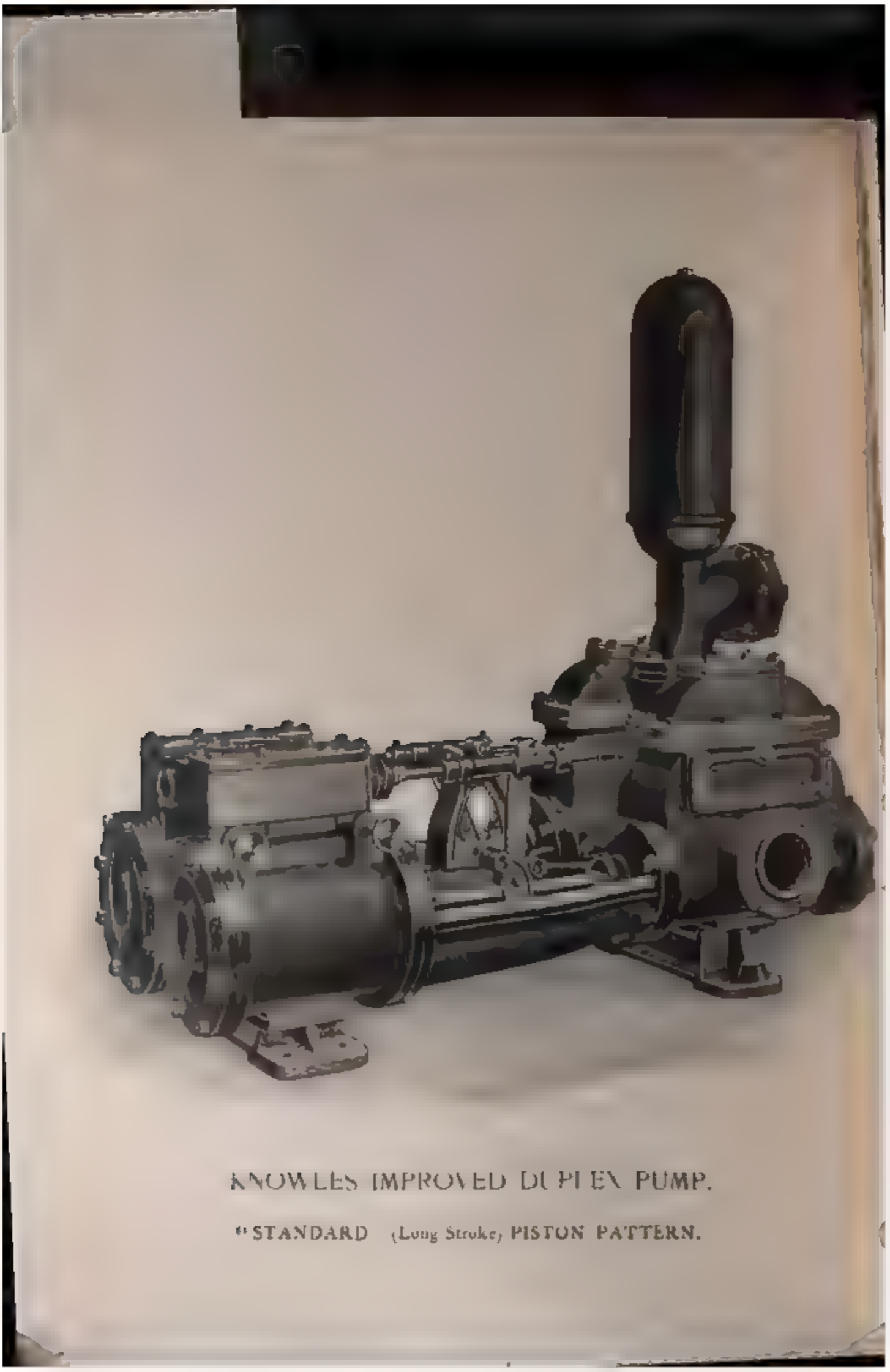
Water Cylinder	Stroke.	Gallons per Stroke	Capacity per Minute at Maximum Speed.		Steam Pipe.	Exhaust Pipe.	Suction Pipe.	Delivery Pipe.	Floor Space Required.	Telegraphic Code Word.
Ins.	Ins.		Strokes.	Gals.	Ins.	Ins.	Ins.	Ins.	Ins.	
3¼	4	.15	125	18	½	¾	2	1½	32 x 9	Forktail
4	5	.27	125	33	½	¾	2	1½	35 x 9	Forky
4	7	.39	125	49	¾	1	2½	2	44 x 9	Forlay
5½	7	.72	125	90	¾	1	3	2½	45 x 10	Forlie
5½	7	.72	125	90	¾	1	3	2½	45 x 13	Formal
6	12	1.47	100	147	¾	1	4	4	66 x 14	Formally
7	12	2.00	100	200	¾	1	5	5	66 x 14	Formate
7	10	1.66	100	166	1	1¼	5	5	56 x 14	Formerly
7½	10	1.91	100	191	1	1¼	5	5	56 x 14	Formful
6	12	1.47	100	147	1	1¼	4	4	66 x 14	Formic
7	12	2.00	100	200	1	1¼	5	5	66 x 14	Formill
8	12	2.61	100	261	1	1¼	5	5	66 x 15	Forpass
9	12	3.30	100	330	1	1¼	6	6	67 x 25	Forpine
10	12	4.08	100	408	1	1¼	6	6	67 x 25	Forsake
9	16	4.40	75	330	1¼	1½	6	6	89 x 25	Forsaking
10	12	4.08	100	408	1¼	1½	6	6	89 x 25	Forslack
10	16	5.44	75	408	1¼	1½	6	6	89 x 25	Forster
12	12	5.87	100	587	1¼	1½	8	6	67 x 25	Forswear
12	16	7.83	75	587	1¼	1½	8	6	89 x 28	Forswonk
10	12	4.08	100	408	2	2½	6	6	89 x 25	Forswore
10	16	5.44	75	408	2	2½	6	6	89 x 25	Forte
12	12	5.87	100	587	2	2½	8	6	70 x 25	Forthink
12	16	7.83	75	587	2	2½	8	6	89 x 28	Fortin
14	16	10.66	75	800	2	2½	10	8	89 x 28	Fortitude
12	12	5.87	100	587	2	2½	8	6	70 x 25	Fortlet
12	16	7.83	75	587	2½	3	8	6	89 x 28	Fortress
14	12	8.00	100	800	2	2½	10	8	78 x 28	Fortuitous
14	16	10.66	75	800	2½	3	10	8	89 x 28	Fortuity
14	24	16.00	50	800	2½	3	10	8	108 x 28	Forum
16	16	14.92	75	1020	2½	3	12	10	89 x 29	Forwaste
16	24	20.88	50	1044	2½	3	12	10	108 x 29	Forweary
14	16	10.66	75	800	2½	3	10	8	90 x 28	Forweep
14	24	16.00	50	800	2½	3	10	8	114 x 28	Fosse
16	16	14.92	75	1020	2½	3	12	10	96 x 29	Fossores
16	24	20.88	50	1044	2½	3	12	10	114 x 29	Fossroad
18	24	26.44	50	1322	2½	3	12	10	118 x 32	Fother
20	24	32.64	50	1632	2½	3	14	12	118 x 32	Fougade
16	24	20.88	50	1044	3½	4	12	10	118 x 29	Foughten
18	24	26.44	50	1322	3½	4	12	10	118 x 32	Foulder
20	24	32.64	50	1632	3½	4	14	12	118 x 32	Fouled
22	24	39.50	50	1975	3½	4	14	14	120 x 35	Fouling
24	24	47.00	50	2350	3½	4	16	16	132 x 39	Foulingly
18	24	26.44	50	1322	3½	4	12	10	128 x 32	Foully
20	24	32.64	50	1632	3½	4	14	12	128 x 32	Foumart
22	24	39.50	50	1975	3½	4	14	14	128 x 35	Founded
24	24	47.00	50	2350	3½	4	16	16	132 x 39	Fount

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

water cylinders are arranged with *composition* linings, valve seats, valve bolts, water pistons, ton rods; the water pistons are packed with a special form of adjustable packing.

iliary Boiler Feed Pumps (single action plungers) attached when required. Prices extra. Pumps ater cylinders entirely of COMPOSITION, EXTRA. The hand-power attachment applied to the first es.

In ordering, parties will please state fully the duty to be performed, also size and length of pipes. sizes up to 8 x 8 x 12 inclusive are of the "flat cap" pattern, good for water pressures correspond- 50 feet head *or less. Larger sizes* have water cylinders of the "close clearance" type, suited for *ead, or less. Copper air chambers* will be furnished, if required, at a slight additional charge.



KNOWLES IMPROVED DUPLEX PUMP.

"STANDARD (Long Stroke) PISTON PATTERN.

KNOWLES IMPROVED

DUPLEX STEAM PUMPS.

"STANDARD" (Long Stroke) PISTON PATTERN

For Feeding Boilers, Etc.

To meet a preference occasionally expressed for a well-made inexpensive duplex pump, to work against moderate pressure, with clear water, such as operating hydraulic elevators, pumping into the tanks of buildings, feeding boilers, etc., we have built a complete set of patterns embodying many decided improvements upon the duplex pumps commonly found in the market.

In the Knowles Improved Duplex Pumps plain slide valves are used of the most durable form, worked by a very simple and adjustable valve motion of improved design. The water pistons and valves are adapted to the liquid to be pumped. **The water cylinders are brass lined.**

The weight of these pumps is from *ten* to *twenty* per cent greater than the duplex pumps of other makers, as commonly built; they also have the advantage of *longer stroke*, and as the wear of the pump depends on the number of *reversals* of motion made in a given time, their durability is proportionately increased by this feature. Another great advantage in the longer stroke is the smaller amount of steam necessary, on account of less clearance, for a given amount of piston speed.

SIZES, CAPACITIES AND PRICES:

Steam Cylinders. Inches.	Water Cylinders. Inches.	Stroke. Inches.	Gallons per Stroke each Piston	Strokes per Minute of each Piston Ordinary Speed.	Capacity of both Cylinders at Speed stated (per Minute). Gallons.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipe. Inches.	Delivery Pipe. Inches.	Floor Space required. Inches.	Price
3	2	3	.046	75 to 200	9 to 18	⅜	½	1¼	1	36 x 12	
4½	2¾	4	.10	75 to 150	15 to 30	½	¾	2	1½	38 x 13	
5¼	3½	6	.24	75 to 150	36 to 72	¾	1¼	2½	2	52 x 20	
6	4	7	.39	75 to 125	58 to 97	1	1½	3	2½	54 x 24	
7½	4½	10	.69	60 to 120	82 to 164	1½	1½	4	3	60 x 24	
8	5	12	1.02	50 to 100	102 to 204	1½	1½	5	4	80 x 31	
8	6	12	1.47	50 to 100	147 to 294	1½	1½	5	4	80 x 31	
10	6	12	1.47	50 to 100	147 to 294	2	2½	5	4	80 x 31	
12	7	12	2.00	50 to 100	200 to 400	2	2½	6	5	83 x 35	
12	8½	12	3.00	50 to 100	300 to 600	2	2½	6	5	83 x 37	
14	8½	12	3.00	50 to 100	300 to 600	2½	3	6	5	83 x 37	
14	10½	12	4.50	50 to 100	450 to 900	2½	3	8	7	83 x 44	
16	10½	12	4.50	50 to 100	450 to 900	3	3	8	7	83 x 44	
16	12	12	5.87	50 to 100	587 to 1174	3	3	10	8	83 x 50	
18½	10½	12	4.50	50 to 100	450 to 900	3	3	8	7	83 x 44	
18½	12	12	5.87	50 to 100	587 to 1174	3	3	10	8	83 x 50	
18½	14	12	8.00	50 to 100	800 to 1600	3	3	12	10	83 x 57	
20	14	18	12.00	40 to 70	960 to 1680	4	6				

PUMPS FITTED WITH COMPOSITION PISTON RODS, ETC., AT A SLIGHT ADDITIONAL COST

KNOWLES SPECIAL DUPLEX PUMP.

Size, 6 x 4 x 6.

The Knowles Special Duplex Pump.

Pressure Pattern, for Boiler Feeding, Etc.

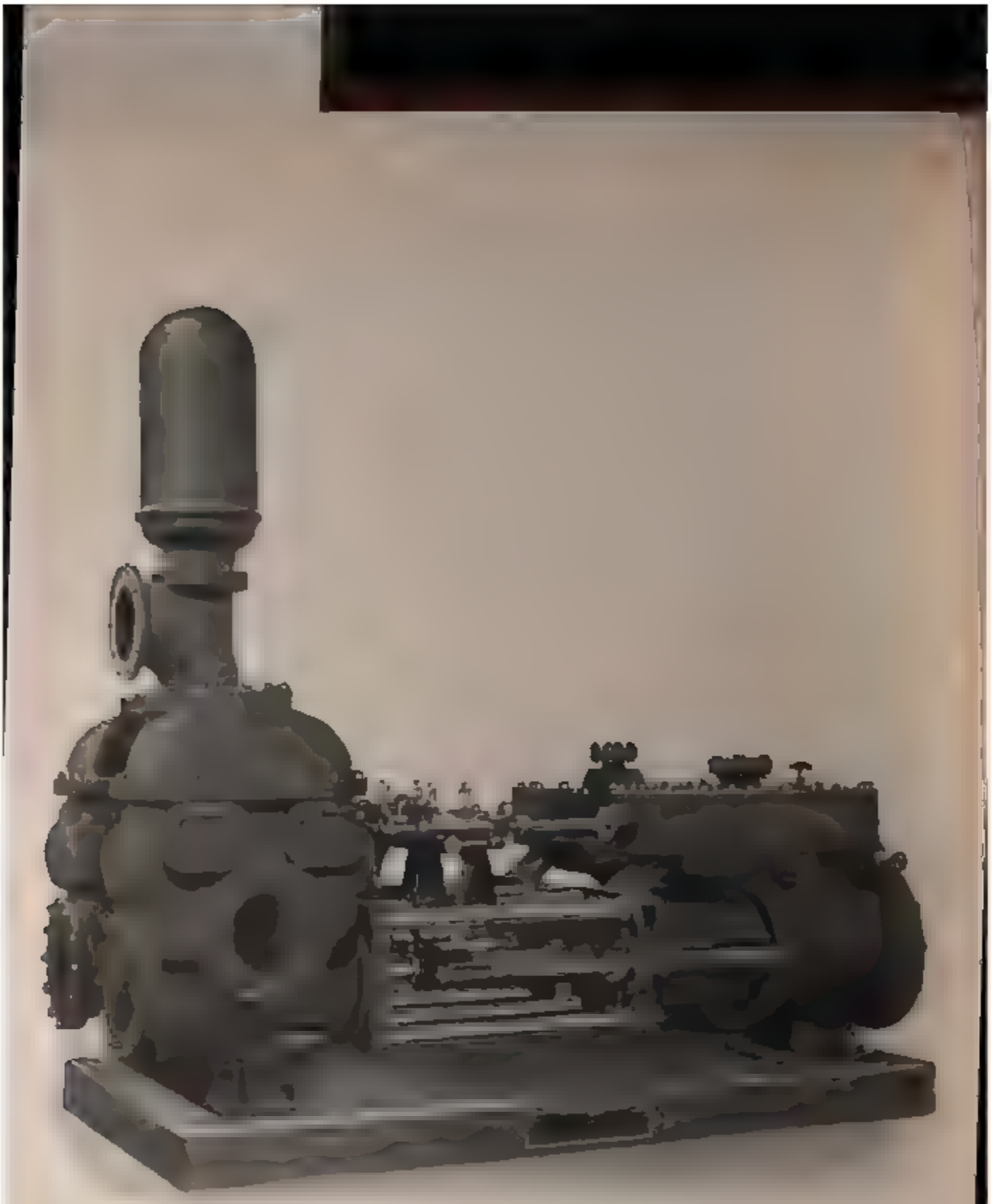
THE cut on opposite page shows one of our special pattern duplex pumps (size, 6 x 4 x These pumps are provided with double acting water pistons, and are suitable boiler feeding, fire service, or for general purposes. The water cylinders are br lined, and the water pistons are arranged so that the packing may be readily renew when required.

Steam Cylinders.	Water Cylinders.	Stroke	Capacity in Gallons per Stroke each Piston.	Strokes per Minute, each Piston	Capacity of Both Cylinders, in Gallons, per Minute.	Steam Pipe	Exhaust Pipe.	Suction Pipe.	Discharge Pipe	Telegraphic Code Word.	
Ins.	Ins.	Ins.				Ins	Ins.	Ins.	Ins	Regular	Brass Fitte
2	1¾	2¾	.014	100 to 300	2 to 8	⅜	½	1	¼	Gabble	Gallisme
3	2	3	.04	100 " 250	8 " 20	⅜	½	1¼	1	Gablet	Gallitos
4½	2¾	4	.10	100 " 200	20 " 40	½	¾	2	2	Gadding	Gallivats
5¼	3½	5	.20	100 " 200	40 " 80	¼	1¼	2½	2½	Gaffer	Gallivespa
6	4	6	.33	100 " 150	66 " 100	1	1½	3	3	Gaffle	Galliwasp
7½	4½	6	.42	100 " 150	85 " 125	1¼	1½	4	3	Gaggling	Galliziano
7½	5	6	.51	100 " 150	100 " 150	1¼	1½	4	3	Gaiety	Gallizzi
7½	4½	10	.69	75 " 125	100 " 170	1¼	1½	4	3	Gaily	Galiloch
9	5¼	10	.93	75 " 125	135 " 230	1½	2	4	3	Gainable	Gallofeets
10	6	10	1.22	75 " 125	180 " 300	1½	2	5	4	Gainful	Gallois
10	7	10	1.66	75 " 125	245 " 410	1½	2	6	5	Gainless	Galloman
12	7	10	1.66	75 " 125	245 " 410	2½	3	6	5	Gainsay	Gallonam
14	7	10	1.66	75 " 125	245 " 410	2½	3	6	5	Gainstand	Gallonassi
12	8½	10	2.45	75 " 125	365 " 610	2½	3	6	5	Garish	Gallonato
14	8½	10	2.45	75 " 125	365 " 610	2½	3	6	5	Garter	Gallonera
16	8½	10	2.45	75 " 125	365 " 610	2½	3	6	5	Galaxy	Galloon
18½	8½	10	2.45	75 " 125	365 " 610	3	3½	6	5	Galbulus	Galloonec
12	10¼	10	3.57	75 " 125	530 " 890	2½	3	8	7	Galiot	Gallopade
14	10¼	10	3.57	75 " 125	530 " 890	2½	3	8	7	Gallant	Gallophot
16	10½	10	3.75	75 " 125	560 " 935	2½	3	8	7	Gallate	Galloping
18½	10½	10	3.75	75 " 125	560 " 935	3	3½	8	7	Galleass	Gallorum
20	10½	10	3.75	75 " 125	560 " 935	4	5	8	7	Gallego	Gallowgla
16	12	10	4.89	75 " 125	730 " 1220	2½	3	10	8	Galleon	Gallows
18½	12	10	4.89	75 " 125	730 " 1220	3	3½	10	8	Gallery	Gallreich
20	12	10	4.89	75 " 125	730 " 1220	4	5	10	8	Gallambic	Galluche
16	14	10	6.66	75 " 125	990 " 1660	2½	3	12	10	Gallian	Gallula
18½	14	10	6.66	75 " 125	990 " 1660	3	3½	12	10	Galliard	Gallulasc
20	14	10	6.66	75 " 125	990 " 1660	4	5	12	10	Gallic	Galluloru
18½	16	12	10.44	50 " 100	1000 " 2000	3	3½	14	12	Gallican	Gallulos
20	16	12	10.44	50 " 100	1000 " 2000	4	5	14	12	Gallicism	Gallulum

ALSO PATTERNS FOR LARGER SIZES.

A slight additional charge is made when pumps are fitted with brass pistons brass piston rods.

To designate the sizes give the diameter of steam and water cylinders and leng *stroke, or use code word.*

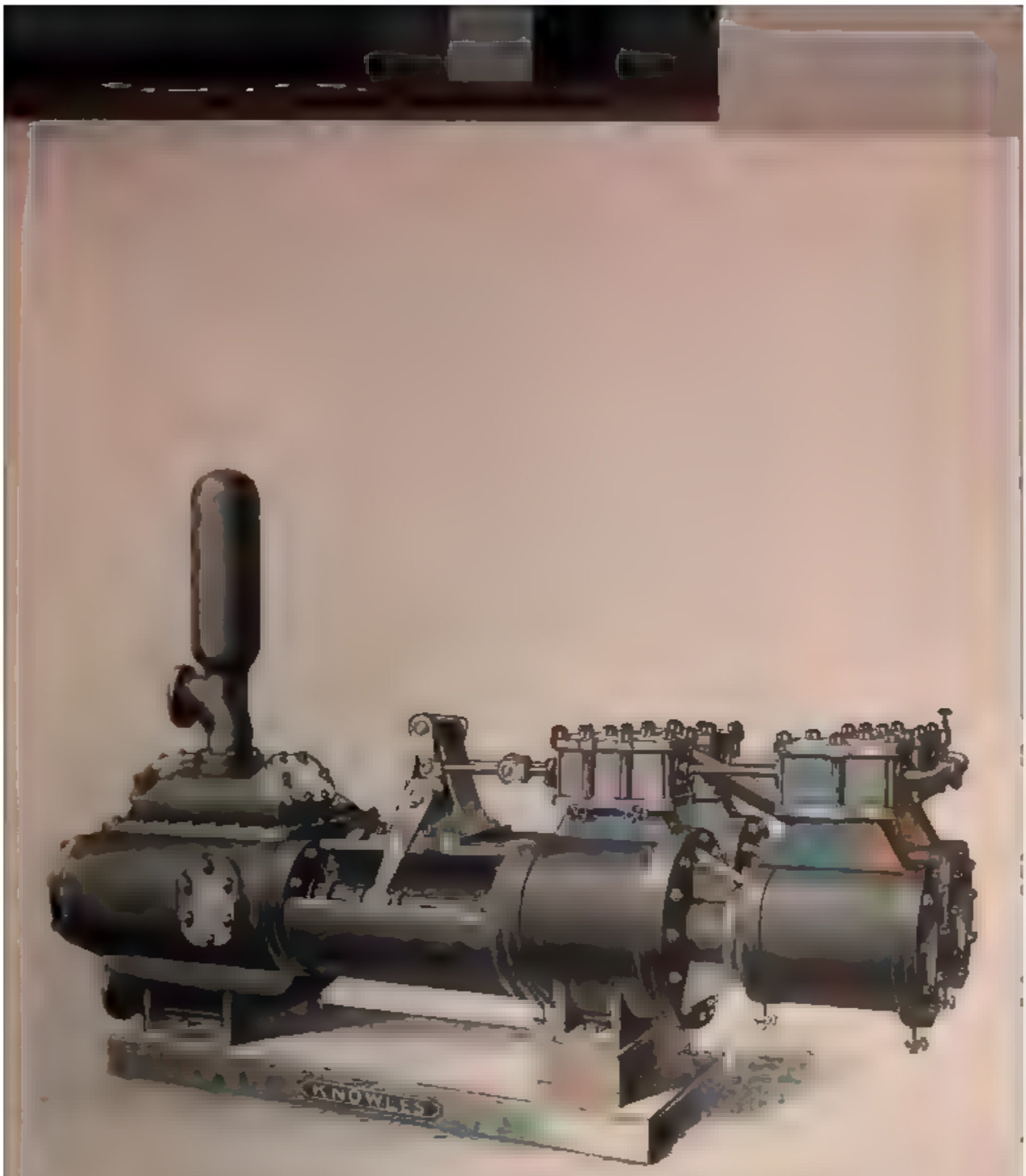


KNOWLES IMPROVED COMPOUND DUPLEX STEAM PUMP.

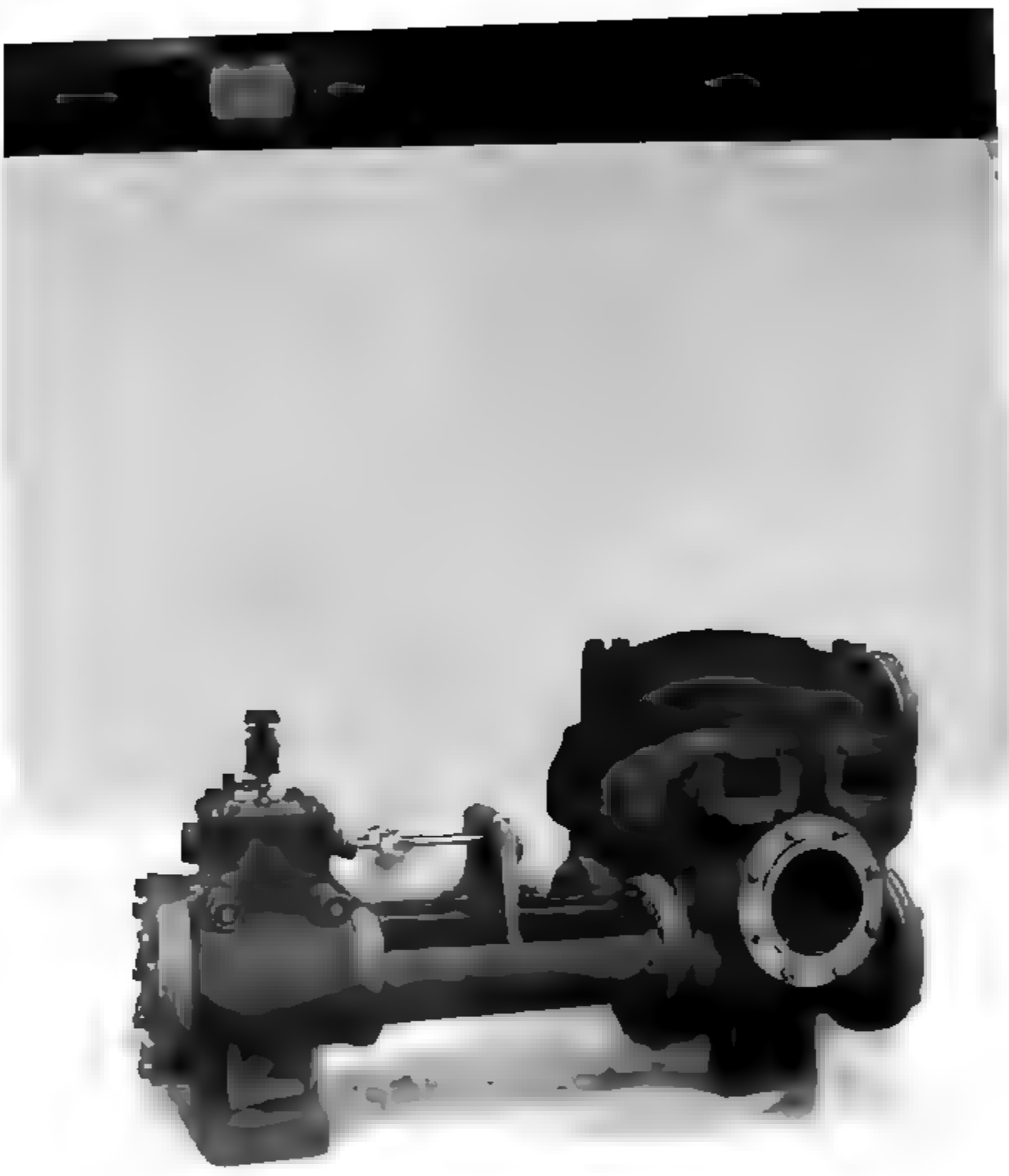
"Standard" Long Stroke Piston Pattern.

Size [illegible] x 14 x 18

(Non-condensing)



KNOWLES COMPOUND SPECIAL NON-CONDENSING
DUPLEX PUMP.



KNOWLES SPECIAL DUPLEX TANK PUMP.

Size, 8 x 10½ x 10.

The Knowles Special Duplex Pump.

Tank, or Light Service Pattern.

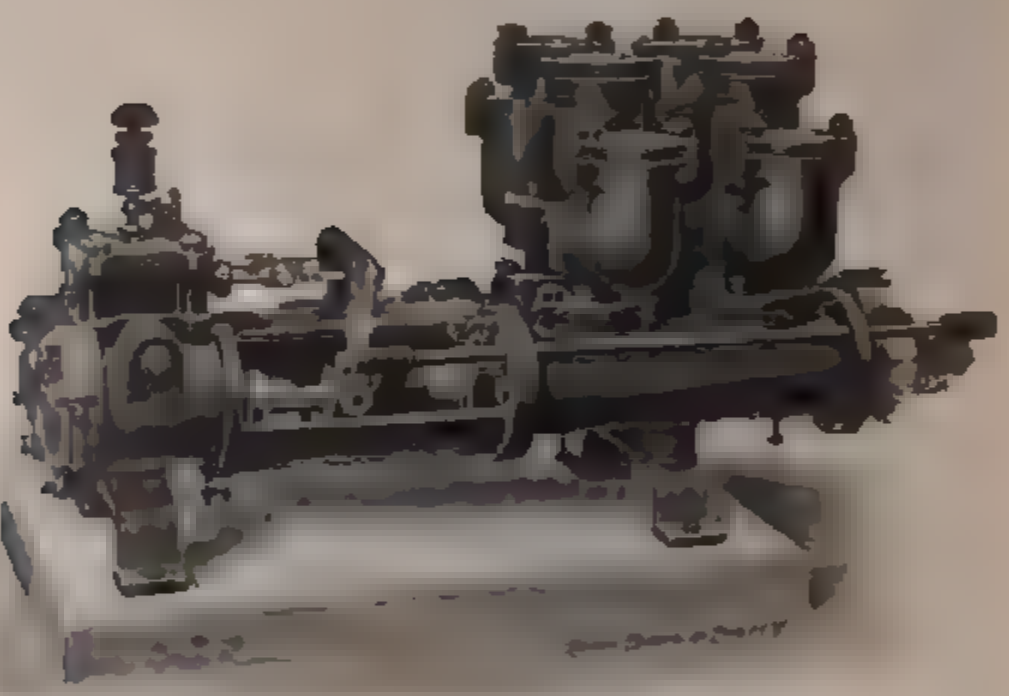
THESE pumps are designed for use where the liquid handled is to be raised only to a moderate height. They are made of the piston pattern, pump pistons fibrous packed, and they are furnished with valves of hard or soft rubber, or of metal, as required, according to the liquid to be handled. Water cylinders are brass lined.

Steam Cylinders.	Water Cylinders.	Stroke.	Capacity in Gallons per Stroke, each Piston.	Strokes per Minute, each Piston.	Capacity of Both Cylinders, in Gallons per Minute.	Steam Pipe.	Exhaust Pipe.	Suction Pipe.	Discharge Pipe.	Telegraphic Code Word.	
Ins	Ins.	Ins.				Ins.	Ins.	Ins.	Ins.	Regular.	Brass Fitted.
3	2¾	3	.08	100 to 200	15 to 30	⅜	½	1¼	1	Geerbtes	Genoegen
4½	3¾	4	.20	100 to 200	40 to 80	½	¾	2½	1½	Geese	Genoemd
5½	4¾	5	.38	100 " 150	75 " 110	¾	1¼	3	2½	Gelable	Genoessig
6	5¾	6	.67	100 " 150	130 " 195	1	1½	4	3	Gelatine	Genoethigt
6	7½	6	1.14	100 " 150	225 " 340	1	1½	6	5	Gelding	Genoffel
7½	6	6	.73	100 " 150	146 " 220	1¼	1½	4	3	Gelidity	Genoilleré
7½	7½	6	1.14	100 " 150	225 " 340	1¼	1½	6	5	Geminate	Genoodigd
6	8½	6	1.47	100 " 150	295 " 440	1	1½	6	5	Gemmary	Genoper
7½	8½	6	1.47	100 " 150	295 " 440	1¼	1½	6	5	Gemmated	Genoplesio
7½	6	10	1.22	75 " 125	180 " 300	1¼	1½	5	4	Gemmule	Genopt
7½	7	10	1.66	75 " 125	245 " 410	1¼	1½	6	5	Gendarme	Genosiride
8	7	10	1.66	75 " 125	245 " 410	1½	2	6	5	Gender	Genovesas
8	7½	10	1.91	75 " 125	285 " 475	1½	2	6	5	Genearch	Genoveva
7½	8½	10	2.45	75 " 125	365 " 610	1¼	1½	6	5	General	Genrebild
8	8½	10	2.45	75 " 125	365 " 610	1½	2	6	5	Generant	Genteelish
8	8½	10	2.45	75 " 125	365 " 610	1½	2	6	5	Generate	Genterella
8	10¼	10	3.57	75 " 125	530 " 890	1½	2	8	7	Generating	Gentezmha
9	10¼	10	3.57	75 " 125	530 " 890	1½	2	8	7	Generic	Genthios
9	10½	10	3.75	75 " 125	560 " 935	2½	3	8	7	Generical	Genthite
9	10½	10	3.75	75 " 125	560 " 935	2½	3	8	7	Generosity	Genticae
9	12	10	4.89	75 " 125	730 " 1220	1½	2	10	8	Gererous	Genticorum
9	12	10	4.89	75 " 125	730 " 1220	2½	3	10	8	Genesis	Genticum
9	12	10	4.89	75 " 125	730 " 1220	2½	3	10	8	Genetic	Gentilibus
10	14	10	6.66	75 " 125	990 " 1660	1½	2	12	10	Genevan	Gentilino
10	14	10	6.66	75 " 125	990 " 1660	2½	3	12	10	Genevese	Gentilismo
10	14	10	6.66	75 " 125	990 " 1660	2½	3	12	10	Genially	Gentilitas

ALSO PATTERNS FOR LARGER SIZES.

A slight additional charge is made when pumps are fitted with brass pistons and brass piston rods.

To designate the sizes give the diameter of steam and water cylinders, and length of stroke, or use code word.



KNOWLES SPECIAL DUPLEX PUMP.

OUTSIDE PACKED PLUNGER PATTERN

Size, 5¼x5x5

This pump can be used as a Filter Press Pump

THE KNOWLES
SPECIAL DUPLEX PUMP

OUTSIDE PACKED PLUNGER PATTERN.

THIS pattern of pump is specially designed for pipe lines, for mining purposes, for feeding boilers carrying very high steam pressures in conformity with the most modern practice, or for any service requiring the delivery of liquids under unusually heavy pressure, not to exceed 250 to 450 pounds per square inch. Owing to the facility with which wear in the water plungers may be taken up, by setting out the packing in the stuffing boxes, these pumps are specially well suited for handling gritty liquids.

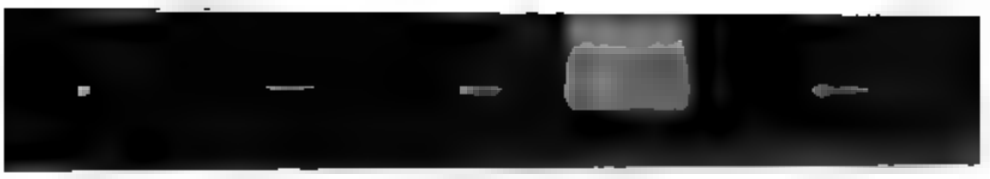
Steam Cylinders.	Water Plungers.	Stroke.	Capacity in Gallons per Stroke, each Plunger.	Strokes per Minute, each Plunger.	Capacity of Both Cylinders in Gallons, per Minute.	Steam Pipe.	Exhaust Pipe.	Suction Pipe.	Discharge Pipe.	Water Pressure Pump End will stand, in lbs., per square inch.	Telegraphic Code Word.	
Ins.	Ins.	Ins.				Ins.	Ins.	Ins.	Ins.		Regular.	Brass Fitted.
3	2	3	.04	100 to 200	8 to 16	¼	½	1¼	1	300	Gialder	Gimmal
4½	2	4	.05	100 " 200	10 " 20	½	¾	1½	1¼	300	Giant	Gimnasta
4½	2½	4	.08	100 " 200	16 " 32	½	¾	2	1½	300	Gianter	Gimnastum
5½	3	5	.15	100 " 200	30 " 60	¾	1¼	2	1½	300	Giantess	Gimnico
6	3½	6	.25	100 " 150	50 " 75	1	1½	2½	2	300	Gibbed	Gimnodermi
6	4	6	.33	100 " 150	67 " 100	1	1½	3	2½	300	Gibbedale	Gimnorinco
7½	4	6	.33	100 " 150	67 " 100	1¼	1½	4	2½	300	Gibbering	Gimpelfang
7½	4½	6	.42	100 " 150	85 " 125	1¼	1½	4	3	300	Gibberinus	Gimpelgelt
7½	5	6	.51	100 " 150	100 " 150	1¼	1½	4	3	300	Gibberipe	Gimpelhatt
7½	4½	10	.69	50 " 100	69 " 138	1¼	1½	4	3	300	Gibberish	Gimpmuehle
7½	5	10	.85	50 " 100	85 " 170	1¼	1½	4	3	300	Gibberos	Ginandria
10	4	10	.54	50 " 100	54 " 108	1½	2	4	3	250	Gibbet	Ginantropo
10	4	10	.54	50 " 100	54 " 108	1½	2	4	3	450	Gibbous	Gindanes
10	5	10	85	50 " 100	85 " 170	1½	2	4	3	250	Giddily	Gindarus
10	5	12	1.02	50 " 100	102 " 204	1½	2	4	3	250	Giddy	Ginebrada
10	6	10	1.22	50 " 100	122 " 244	1½	2	5	4	250	Giebelgeld	Ginecomane
10	6	12	1.47	50 " 100	147 " 294	1½	2	5	4	250	Giebelmoos	Ginestrina
12	4	10	.54	50 " 100	54 " 108	2½	3	4	3	450	Giedroyc	Ginetado
12	4	12	.65	50 " 100	65 " 130	2½	3	4	3	450	Giegelde	Gingar
12	5	10	85	50 " 100	85 " 170	2½	3	4	3	400	Giekijzers	Gingeole
12	5	12	1.02	50 " 100	102 " 204	2½	3	4	3	400	Gienalle	Gingerade
12	6	10	1.22	50 " 100	122 " 244	2½	3	5	4	400	Gienmaul	Gingerly
12	6	12	1.47	50 " 100	147 " 294	2½	3	5	4	400	Giereklauw	Gingerness
12	7	10	1.66	50 " 100	166 " 332	2½	3	6	5	400	Gierende	Gingibrine
12	7	12	2.00	50 " 100	200 " 400	2½	3	6	5	400	Gierenoog	Gingidion
12	7½	10	1.91	50 " 100	191 " 382	2½	3	6	5	400	Gierevedet	Gingiliphio
12	7½	12	2.30	50 " 100	230 " 460	2½	3	6	5	400	Gierigaard	Gingillano
14	5	10	.85	50 " 100	85 " 170	2½	3	4	3	300	Gierpont	Gingillare
14	5	12	1.02	50 " 100	102 " 204	2½	3	4	3	300	Gierput	Gingillava
14	6	10	1.22	50 " 100	122 " 244	2½	3	5	4	300	Giersch	Gingitic
14	6	12	1.47	50 " 100	147 " 294	2½	3	5	4	300	Giersties	Gingival
14	6	15	1.80	40 " 80	176 " 352	2½	3	6	5	450	Giervalk	Gingivarum
14	7	10	1.66	50 " 100	166 " 332	2½	3	6	5	300	Gierzwaluw	Gingivite
14	7	12	2.00	50 " 100	200 " 400	2½	3	6	5	300	Giessbad	Gingivula
14	7	18	3.00	40 " 80	240 " 480	2½	3	7	6	450	Giessen	Gingivulis
14	7½	10	1.91	50 " 100	191 " 382	2½	3	6	5	300	Giesskelle	Gingkosite
14	7½	12	2.30	50 " 100	230 " 460	2½	3	6	5	300	Giessmodel	Ginglymo
14	8	10	2.18	50 " 100	218 " 436	2½	3	7	6	300	Giesstisch	Ginglymus
14	8	12	2.61	50 " 100	261 " 522	2½	3	7	6	300	Giestal	Gingoule
14	8	18	3.91	40 " 80	312 " 625	2½	3	8	7	450	Gietbaden	Gingrianus
14	8½	18	4.50	40 " 80	360 " 720	2½	3	8	7	400	Gietemmers	Gingriendo
14	9	12	3.30	50 " 100	330 " 660	2½	3	8	7	250	Gieterijen	Gingrine
14	9	18	4.95	40 " 80	396 " 792	2½	3	8	7	250	Giethuizen	Gingrinis
16	5	10	.85	50 " 100	85 " 170	2½	3	4	3	450	Gietkan	Gingrirent

THE KNOWLES COMPOUND SPECIAL DUPLEX PUMP.

Outside Packed Plunger Pattern

Size [illegible]

This pump can be used as a Filter Press Pump.



THE KNOWLES SPECIAL DUPLEX PUMP—CONTINUED.

OUTSIDE PACKED PLUNGER PATTERN.

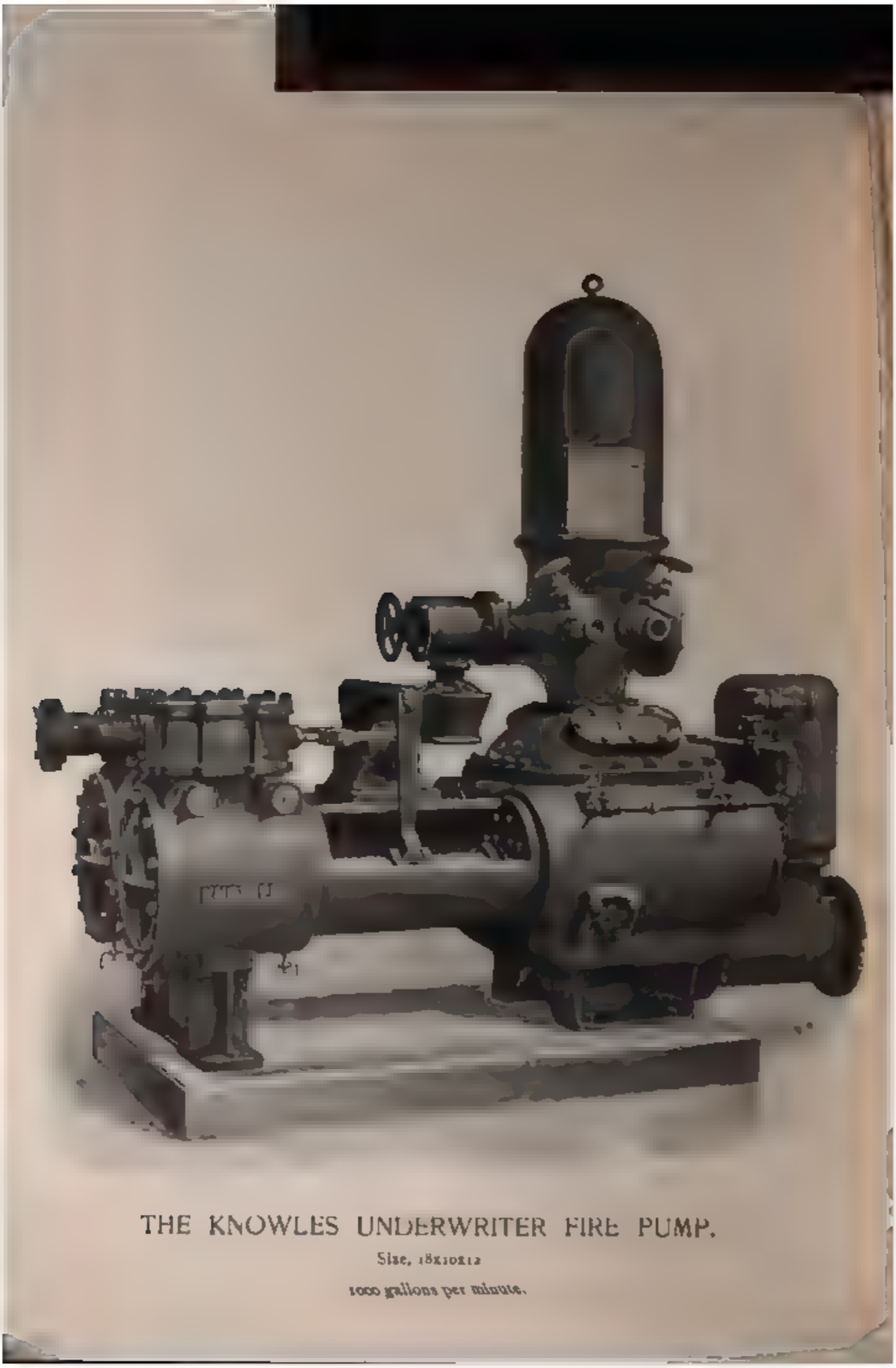
Steam Plungers.	Stroke.	Capacity, in Gal lons, per Stroke each Plunger	Strokes per Minute, each Plunger.	Capacity of Both Cylinders, in Gallons, per Minute.	Steam Pipe.	Exhaust Pipe.	Suction Pipe.	Discharge Pipe.	Water Press Pump End will stand, in lbs. per square inch.	Telegraphic Code Word.	
Ins.	Ins.				Ins.	Ins.	Ins.	Ins.		Regular.	Brass Fitted.
5	12	1.02	50 to 100	102 to 204	2½	3	4	3	450	Gietketel	Gingunum
5½	20	1.22	50 " 100	122 " 244	2½	4	5	4	450	Gietkunst	Ginnadenia
5½	12	1.47	50 " 100	147 " 294	2½	4	5	4	450	Gietnaad	Ginnasio
6	18	2.20	40 " 80	176 " 352	2½	4	6	5	450	Gietsel	Ginnethon
7	10	1.66	50 " 100	166 " 332	2½	4	6	5	300	Giettafels	Ginnichie
7	12	2.00	50 " 100	200 " 400	2⅝	4	6	5	400	Giettappen	Ginnikende
7½	10	1.91	50 " 100	191 " 382	2½	4	6	5	400	Gietvorm	Ginno
7½	12	2.30	50 " 100	230 " 460	2½	4	6	5	300	Giffleras	Ginnocarpi
7	18	3.00	40 " 80	240 " 480	2½	5	7	6	450	Giffleront	Ginnoclado
7½	18	3.44	40 " 80	275 " 550	2½	5	7	6	450	Giftappels	Ginnocrito
8	20	3.18	50 " 100	318 " 636	2½	5	7	6	300	Giftbecher	Ginnonoti
8	12	2.61	50 " 100	261 " 522	2½	5	7	6	400	Giftblase	Ginnopedia
8	18	3.92	40 " 80	312 " 624	2½	5	7	7	450	Giftdamp	Ginnostilo
8½	18	4.50	40 " 80	360 " 720	2½	5	8	7	400	Giftedness	Ginnotteri
9	12	3.30	50 " 100	330 " 660	2½	5	8	7	250	Gifterz	Ginnus
9	18	4.05	40 " 80	306 " 792	2½	5	8	7	250	Giftgrillen	Ginocchio
7	10	1.66	50 " 100	166 " 332	3	5½	6	5	150	Gifthaus	Ginopogeno
7	12	2.00	50 " 100	200 " 400	3	5½	6	5	200	Giftgheid	Ginousele
7	10	1.66	50 " 100	166 " 332	3	5½	6	5	350	Giftigsten	Ginsao
7	12	2.00	50 " 100	200 " 400	3	5½	6	5	400	Giftkrabbe	Gioachino
7½	10	1.91	50 " 100	191 " 382	3	5½	6	5	300	Giftkugel	Giobbe
7½	12	2.30	50 " 100	230 " 460	3	5½	6	5	300	Giftmittel	Giocammo
8	10	2.18	50 " 100	218 " 436	3	5½	7	6	200	Giftpleil	Giocando
8	10	2.18	50 " 100	218 " 436	3	6	7		400	Giftrinne	Giocandolo
8	12	2.61	50 " 100	261 " 522	3	6	7	7	300	Giftsack	Giocaria
8	12	2.61	50 " 100	261 " 522	3	6	7	7	450	Giftspitz	Giocarono
8	18	3.91	40 " 80	312 " 624	3	5½	8	7	450	Giftstein	Giocasse
8½	18	4.50	40 " 80	360 " 720	3	6	8	7	400	Gifttanden	Giocassimo
9	18	4.05	40 " 80	306 " 792	3	6½	8	7	300	Gifttrank	Giocavamo
7	12	4.08	50 " 100	408 " 816	3	6½	8	7	250	Giftwerend	Giocavate
	18	6.12	40 " 80	490 " 980	3	6½	8	8	450	Giftzahn	Giocherai
7	12	2.61	50 " 100	261 " 522	4	5	8	7	150	Gigajoga	Giocheremo
8	18	3.91	40 " 80	312 " 625	4	5	8	7	450	Gigantessa	Giochiate
8½	18	4.50	40 " 80	360 " 720	4	5	8	7	400	Gigantical	Giocolanimo
9	12	3.30	50 " 100	330 " 660	4	5	8	7	50	Gigantino	Giocolarsi
9	18	4.05	40 " 80	406 " 792	5	5	8	8	250	Gigantone	Giocolato
9	12	4.08	50 " 100	408 " 816	4	5	10	8	250	Giggets	Giocolava
8	18	6.12	40 " 80	490 " 980	4	6	10	8	250	Gigliozzo	Giocolerai

ALSO PATTERNS FOR LARGER SIZES.

e mining work, when so ordered, suction opening will be made same diameter as plunger, except 7½ inches and s, which will be made 7 inches and 8 inches diameter respectively. Discharge opening will be for next smaller than suction pipe. A slight additional charge is made when pumps are fitted with brass plungers. To designate give the diameter of steam and water cylinders and length of stroke, or use code word. We have also patterns s of the above type suited for much heavier pressures than those named in the table. For these we will quote rices on application.

COMPOUND DUPLEX PLUNGER PUMPS. CONDENSING AND NON-CONDENSING.

e have patterns from new and improved designs, embodying all the latest improvements, for different sizes of Plunger Pumps built on the compound plan, as illustrated on opposite page. This will work under the heaviest s, with the *minimum* consumption of steam. *Estimates given on application.*



THE KNOWLES UNDERWRITER FIRE PUMP.

Size, 18x10x12

1000 gallons per minute.

[redacted]

THE KNOWLES
UNDERWRITER FIRE PUMP.

MUTUAL INSURANCE COMPANIES' SPECIFICATIONS.

IN our Underwriter Fire Pump, the water passages, valve areas, and suction and discharge nozzles are all much larger than in any ordinary pump, so a greater amount of water can be discharged without water-hammer. Also, the steam and exhaust ports and nozzles are designed so as to give unrestricted passage to the steam. The pump is "rust-proof," and will start instantly, after standing unused for a long time. The piston rods and valve rods are made from Tobin bronze. All stuffing-boxes and glands are brass lined. Plungers and plunger sleeve are of composition, but the metals are differently mixed to prevent cutting. This mixture of the metals has been a subject of much experiment and study; it has now brought us great success, as the parts work perfectly upon each other, without friction or impairment.

Each pump has the following fittings, heretofore charged as extras, but now included in the price and regularly furnished:

Capacity-Plate on Discharge Air-Chamber.
Stroke-Gauge, graduated on each end.
Vacuum, or Suction Air-Chamber.
Steam-Gauge, 5 inches diameter.
Water-Gauge, 5 inches diameter, with duplex spring.
Relief-Valve of large capacity.
Relief-Valve Discharge-Cone.
Set of brass priming Pipes and special valves.
Required number of 2½ inches Ludlow Hose-Valves.
One pint Sight-Feed Cylinder-Lubricator.
All according to the specifications.

On account of the larger passageways, brass parts and attachments mentioned, the pump necessarily costs more than an ordinary fire pump; but the cost by the gallon discharged is less, since the Underwriter pump can deliver a greater quantity of water in the same length of time. It is also much heavier and stronger, with superior workmanship, and better protected from rust and accident.

TABLE OF SIZES AND CAPACITIES.

Diameter of Steam Cylinders.	Diameter of Water Plungers.	Length of Stroke.	Normal Capacities, Gallons per Minute.	Number of Fire Streams.	Steam Pipe.	Exhaust Pipe.	Suction Pipe.	Discharge Pipe.	Code Word.
12	6	12	320	1	2½	3	6	5	Ensign
14	7¼	12	500	2	3	4	8	6	Ensigncy
16	9	12	750	3	3½	4	10	7	Enskied
18	10	12	1000	4	4	5	12	8	Enslave
20	12	16	1500	6	5	6	14	10	Ensnarl

The actual capacity of each pump is more than the Underwriters' rating, and a greater speed can be attained, that will increase the number of fire streams.

KNOWLES AUTOMATIC FEED PUMP AND RECEIVER.

Size, 6x4x6.

[redacted]

THE KNOWLES

AUTOMATIC FEED PUMP & RECEIVER

is the simplest and most effective apparatus made for draining Steam Coils, Radiators, Heaters, Drying Cylinders, Steam Jackets, etc., and forcing the water of condensation in its hottest condition direct to the steam boilers. It is perfectly reliable and automatic in its operation. It does away with the expense and annoyance of traps and tanks and returns the condensed steam to the boiler in a steady, continuous flow, as fast as it accumulates in the receiver. The Automatic Feed Pump and Receiver can be used for other purposes than a boiler-feed appliance; for instance, for regulating the brine circulation in refrigerating machinery, for the temporator apparatus in beer cooling and for other circulating purposes.

This apparatus also makes an efficient form of governor for maintaining a uniform water level in steam heating systems. When used for this purpose the receiver is placed at the height at which it is required to maintain the water line. When desired, the receiver and pump may be separated, the receiver being placed at the water line level, and the pump located below at any convenient point.

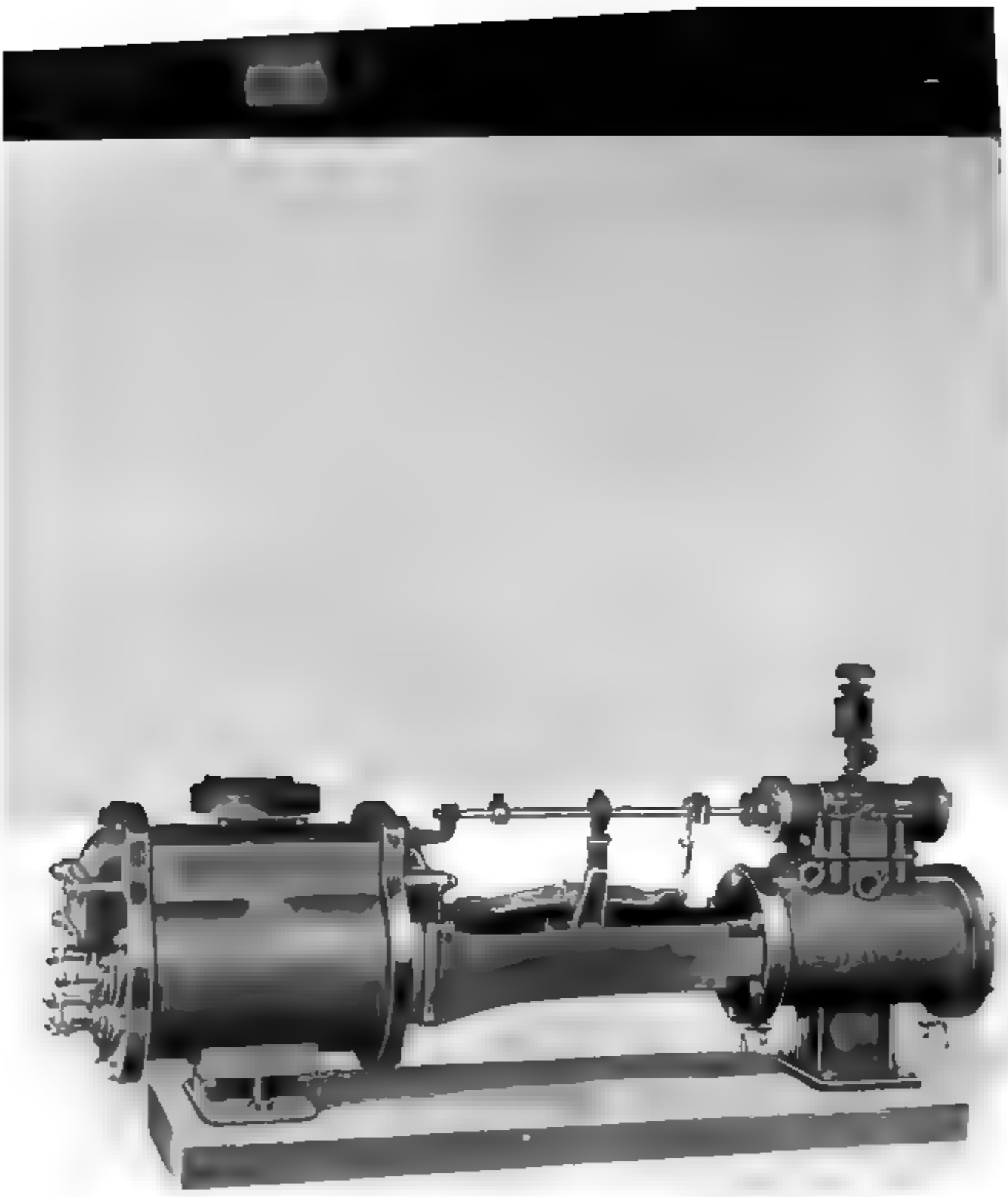
Referring to the illustration on the opposite page, it will be noticed that the condensed steam enters by the inlet nozzle at the top, and falls to the bottom of the receiver. This water cannot accumulate in any quantity, as in rising, it lifts the float, and the steam pump takes it away immediately and forces it to the boiler. The pump is operated from the float by means of the intermediate connections, and balanced steam throttle. When the float rises the pump is started, and the speed is regulated according to the quantity of water flowing into the receiver—the larger the quantity of water the faster the pump moves. The pump slows down as the supply of water drops off, and when it ceases the pump stops entirely.

Size of Pump. (Duplex)	Square Feet of Direct Radiating Surface it will Drain.	Space Occupied, inches.			Telegraphic Code Word.	
		Length.	Width.	Height.	Regular.	Brass Fitted.
3 × 2 × 3	5,000	34	25	31	Meabilibus	Meandrous
4½ × 2¾ × 4	10,000	37	30	35	Meabilium	Meaningly
5¼ × 3½ × 5	20,000	48	37	44	Meaculam	Meapte
6 × 4 × 6	40,000	48	37	45	Meaculatem	Measles
7½ × 5 × 6	70,000	54	44	48	Meadow	Meationem
7½ × 4½ × 10	70,000	63	44	48	Meagrely	Meationis

Prices include everything shown in the illustration.

We also furnish this apparatus when required with the receiver mounted directly over the pump.

Prices upon application.



KNOWLES IMPROVED DIRECT-ACTING AIR COMPRESSOR.

Direct Acting Air Compressors.

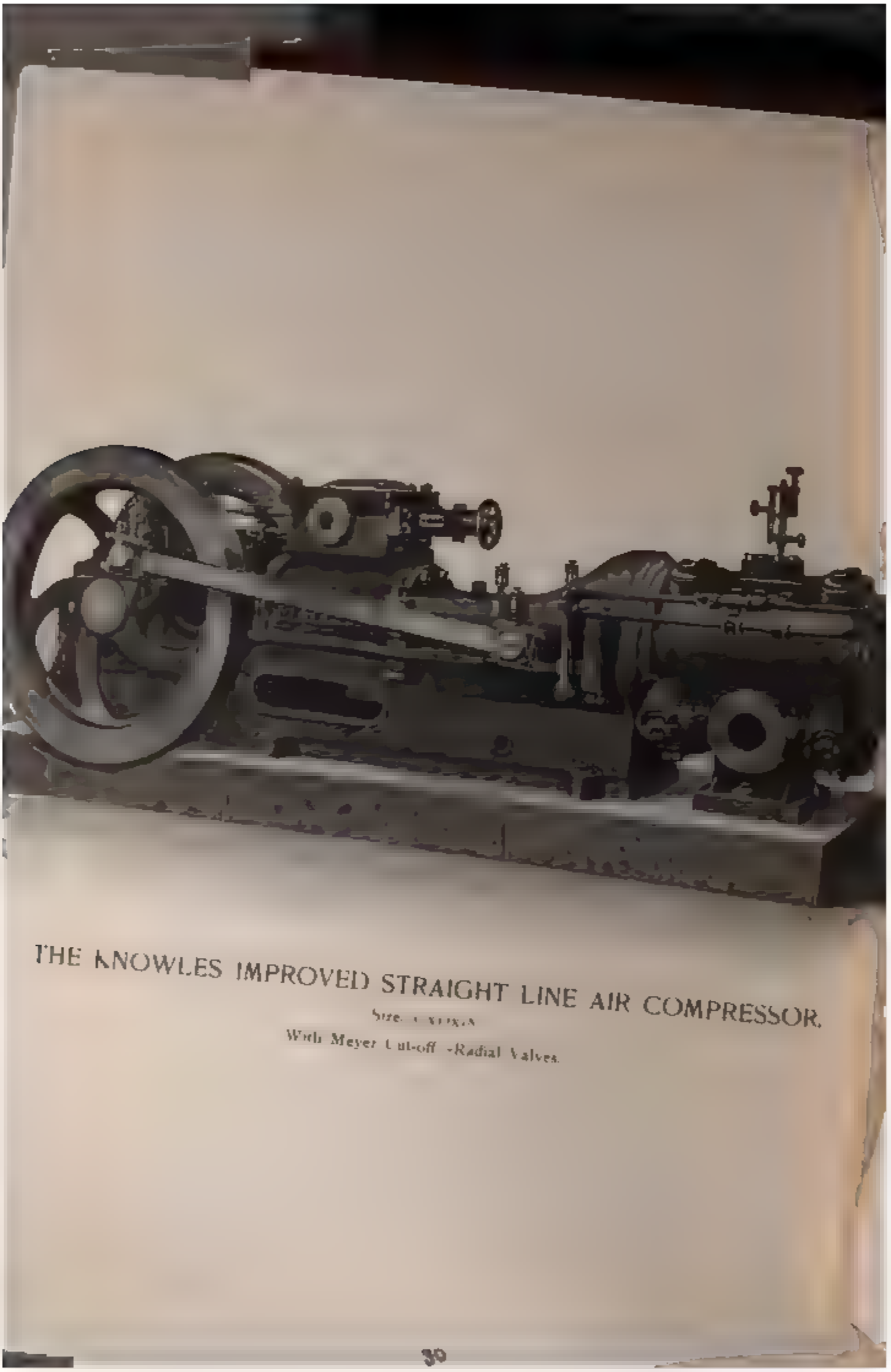
For 5 to 15 Pounds Pressure.

THESE machines are largely used for agitating oils, acids and chemical preparations; also for blast and ventilating purposes, and for supplying air for pneumatic delivery systems and cash carriers. Being direct acting, they are very compact and simple, with the fewest number of working parts possible, and the cost of attendance and maintenance is comparatively nothing. They are universally used in the oil refineries of this country and Russia, and are extensively employed in smelting works, blast furnaces, etc.

Our improved compensating valve motion is of special value on these blowing engines, as the length of stroke can be readily and finely adjusted, so that the pistons can be made to travel close to the heads of the air cylinders, thus combining economy of steam with the most efficient operation at the air end. The air valves are not liable to derangement, and are of very durable form. The pistons are light and strong, and are provided with adjustable packing rings of improved design.

Diameter of Steam Cylinder.	Diameter of Air Cylinder	Stroke	Revolutions or Double Strokes Per Minute	Cubic Feet of Free Air Per Minute	Cubic Feet of Free Air Per Revolution.	Horse Power of Boiler Required.	Pipes. Steam	Pipes. Exhaust.	Pipes. Suction.	Pipes. Discharge.	Dimensions. Length	Dimensions. Width	Dimensions. Height.	Telegraphic Code Word. Open Suction.	Telegraphic Code Word. Confined Suction.
4	4½	5	100	9	09	1½	¼	1½	1½	2'	10"	8"	13"	Helpmate	Hepatite.
4½	6	6	100	19	19	2½	¼	3	2	3'	5"	11"	15"	Helve.	Hepatize.
5½	8		100	40	.40	3½	¼	4	3	3'	10"	13"	16"	Helvetic	Heppen
5½	10		100	62	.62	5½	¼		3	4'	1"	15"	19"	Helvin	Heptade.
6	8	12	75	51	.68	7	¼			4'	6"	13"	16"	Hemachate	Heptarch.
6	10	12	75	80	1.06	10½	¼		3	5'	0"	15"	17"	Hematin	Herald
6	15	6	75	90	1.20	12	¼		2½	4'	3"	13"	20"	Hematite	Heralded
7	12	12	75	115	1.53	16	1			6'	1"	17"	22"	Hemina	Heraldry
8	14	12	75	156	2.08	21	1			6'	2"	16"	20"	Hempier	Herbal
10	16	16	50	150	3.00	25	1¼	6	5	7'	0"	20"	28"	Hemitone	Herbary.
10	16	16	50	205	4.10	28	1¼	6	5	7'	1"	20"	25"	Hemmel	Herbelet.
10	18	16	50	230	4.60	31	1¼		5	7'	4"	23"	30"	Hemp	Herber
10	18	18	50	260	5.20	35	1¼		5	7'	5"	24"	31"	Hempen	Herbert
10	20	16	50	285	5.70	40	1½	6		6'	6"	27"	28"	Herding	Herring
10	20	18	50	320	6.40	44	1½	6	5	7'	0"	25"	31"	Heremet	Hexade.
10	20	24	40	315	8.62	46	1½	6	5	8'	1"	25"	31"	Heretog	Hexagon.
12	24	24	40	490	12.25	68	2	10	10	9'	0"	28"	35"	Herod	Hexapla.
12	30	24	40	770	19.25	100	2	2½	10	11	0'	0"	31"	41"	Herrisson	Hexadod.
14	24	24	40	490	12.25	65	2½		10	10	9'	1"	28"	37"	Herriot	Heyday.
14	30	18	40	640	12.80	85	2½	3	10	8	7'	0"	30"	42"	Hernhill	Hilled
14	30	24	40	770	19.25	100	3	5	10	10	9'	7"	31"	50"	Herma	Hilliness.
14	30	36	25	720	28.8	95	3	5	10	10	13'	0"	31"	40"	Hernshaw	Hills
16	30	36	25	720	28.8	95	3	5	10	10	13'	3"	31"	50"	Heroical	Hilted.
18	30	36	25	720	28.8	95	3	6	10	10	13'	1"	31"	50"	Herome	Hilum.
18	36	36	25	1040	41.6	135	3	8	12	12	13'	10"	42"	50"	Heron	Hinder.
20	36	36	25	1040	41.6	135	3½	8	12	12	13'	10"	42"	50"	Heronry.	Hinderance.
20	42	48	20	1400	56	175	3½	10	14	14	17'	0"	49"	63"	Heroship	Hindered.
24	48	48	20	2000	100	260	5	14	14	14	17'	6"	56"	66"	Herpes	Hinging.

Compressors fitted with "Open" suction take their air supply directly from the atmosphere surrounding the air cylinders. Compressors with "Confined" suction have the suction valves enclosed in a confined space, with an opening to which a pipe may be attached, so as to draw the supply for the compressor from any desired source.



THE KNOWLES IMPROVED STRAIGHT LINE AIR COMPRESSOR.

Size. [illegible]

With Meyer Cut-off -Radial Valves.

THE KNOWLES
SINGLE CYLINDER CRANK AND FLY-WHEEL
AIR COMPRESSOR.

For Elevating Acids by Air Pressure, for Operating Pneumatic Machinery, etc.

THESE "Straight-Line" Air Compressors are made, in the smaller sizes, with the air valves located in the air cylinder heads. The larger sizes may be provided with radial valves located around the air cylinder barrel, as shown in the cut on the opposite page. It will be seen at a glance that this type of compressor is very compact and thoroughly self-contained, and, when properly set, its perfect alignment in continuous service can be relied upon.

Steam and air cylinders are both provided with sight feed lubricators, and all the bearings are fitted with sight feed oil cups. The air cylinder is "water jacketed," and so arranged that the cooling water enters at the compression ends of the cylinder, and after the heat due to compression is absorbed, the water is discharged at the centre.

In large plants where the saving in steam consumption is sufficient to warrant the extra cost, these compressors are fitted with Corliss valve gear and may be run condensing or non-condensing.

Where the air or gas is required to be compressed to pressures greater than about one hundred pounds per square inch, we recommend the use of a compressor with *compound air end*, having two or more air cylinders of different sizes. The initial compression takes place in the larger cylinder. After this first compression, the air or gas passes on to the next cylinder, where the pressure is still further increased, and, if there is a third air cylinder, the process is again continued until the required pressure is reached.

SIZES AND CAPACITIES.— .—STYLES A AND B.

Diameter of Steam Cylinder.	Diameter of Air Cylinder.	Length of Stroke.	Number of Revolutions per Minute.	Cubic Feet of Free Air per Minute.	No. of 3 in Drills or Coal Cutters Compressor will run	Size of Steam Pipe.	Size of Exhaust Pipe.	Size of Air Pipe.	Weight of Compressor Complete.	Telegraphic Code Word.
6	5	7	180	29		1	1½	1½	1000	Farrier
6	6	7	180	42		1	1½	1½	1100	Farrow
6	7	7	180	56		1	1½	1½	1700	Farthest
8	7	7	180	56		1¼	2	2	1800	Farthing
8	8	7	180	73		1¼	2	2	1900	Fascicle
8	8	12	160	112	1	1½	2½	2½	2000	Fascinate
8	10	12	160	175	2	1½	2½	3	3000	Fashion
10	10	12	160	175	2	2	3	3	4100	Fastener
10	12	12	160	250	3	2	3	3½	4900	Fastening
10	12	15	140	292	3	2	3	3½	6100	Faster
12	10	12	160	175	2	2½	3½	3	5000	Fastidious
12	12	12	160	250	3	2½	3½	3½	5200	Fasting
12	12	16	140	292	3	2½	3½	3½	6300	Fatal
12	14	16	140	300	5	2½	3½	4	8100	Fatalist
14	12	16	140	292	3	3½	4	3½	8200	Fatality
14	14	16	140	390	5	3½	4	4	9500	Fatally

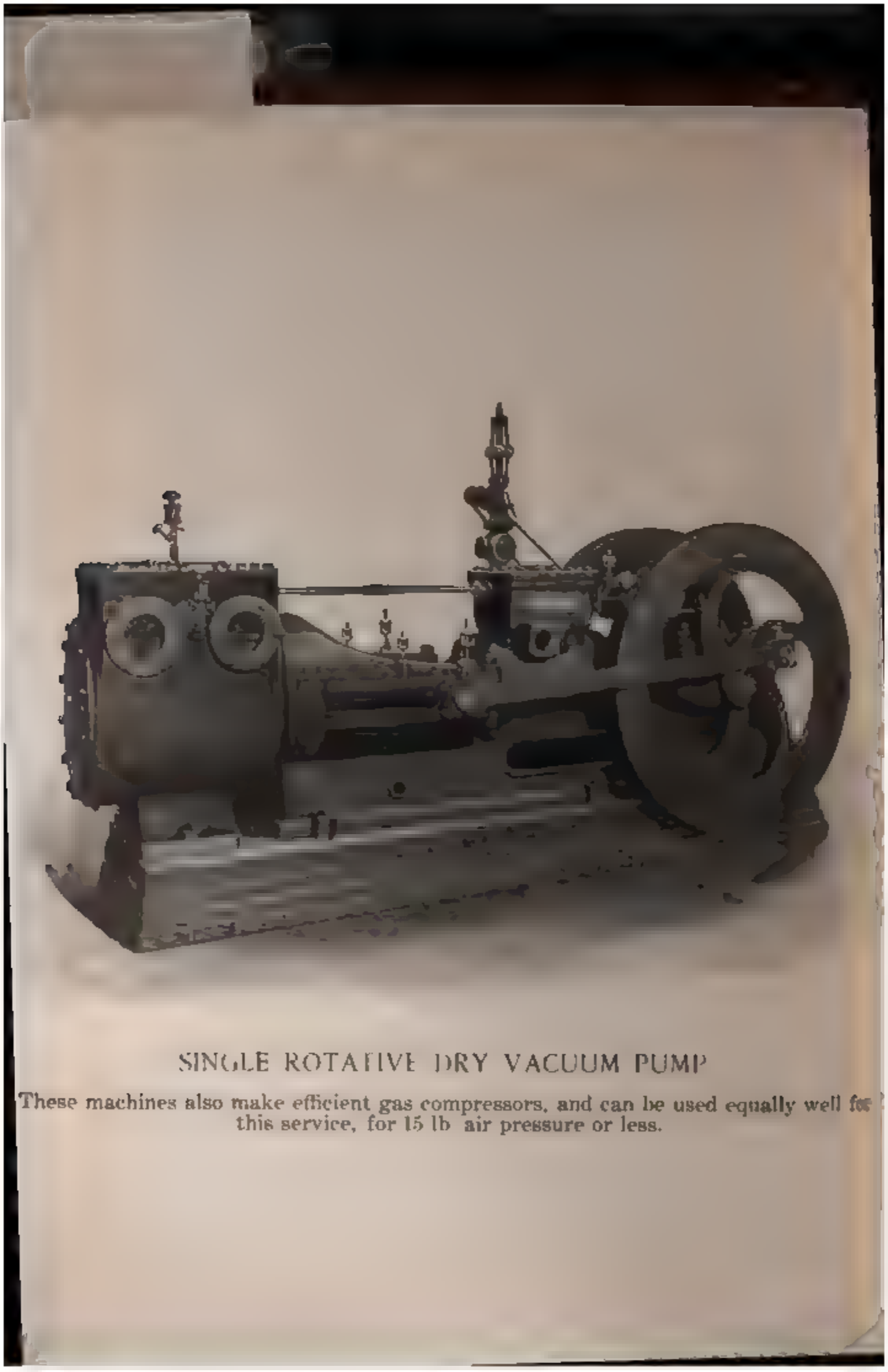
WITH RADIAL VALVES.—STYLE C.

12	12	18	120	282	3	2½	3½	3½	8000	Fated
*12	12	18	120	282	3	2½	3½	3½	9700	Fateful
12	14	18	120	385	5	2½	3½	4	10800	Father
*12	14	18	120	385	5	2½	3½	4	11800	Fatherly
14	14	18	120	385	5	3	4	4	11500	Fathom
*14	14	18	120	385	5	3	4	4	12000	Fatigue
*14	16	18	120	502	7	3	4	4½	12500	Fatling
*16	16	18	120	502	7	3½	4	4½	14000	Fatly
*16	18	18	120	634	9	3½	4	5	16000	Fatness
*18	18	18	120	634	9	4½	5	5	18000	Fatras
*16	18	24	95	670	10	4	5	5	20000	Fatted
*18	18	24	95	670	10	4½	5	5	23000	Fatten
*18	20	24	95	828	12	5	5	6	24000	Fattish
*20	20	24	95	828	12	5	6	6	25000	Fatty
*24	24	30	75	1177	16	6	7	6	34600	Fatuity

* Table gives weight when fitted with Meyer cut-off.

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

The Meyer cut-off attachment, shown in the cut on the opposite page, is only furnished when specially ordered, and is charged *extra*. *Cut shows radial valves.* Send for special catalogue of air compressing machinery.



SINGLE ROTATIVE DRY VACUUM PUMP

These machines also make efficient gas compressors, and can be used equally well for this service, for 15 lb air pressure or less.

KNOWLES IMPROVED

ROTATIVE DRY VACUUM PUMP.

THIS is a new form of vacuum pump of the type used for the dry system, and has been designed and constructed to meet requirements calling for pumps of large capacity with high degree of vacuum, such as in the case of sugar refineries and vacuum pans in general, for preserving processes, for removal of air from underneath covers in canning goods, and for central condensing systems.

This machine is built both of the single type and of the duplex type. It will be seen by the illustrations, both single and duplex, that the machines are compact, substantial and simple, with double-acting steam cylinders, and double-acting vacuum cylinders, the pistons operating in both being mounted on the same piston rod. The fly-wheels are of such weight as to admit of operation at very slow speed. No water is used inside the vacuum cylinders for cooling. The vacuum cylinders are cooled by means of water jackets either in the cylinder heads or in the barrels of cylinders. The suction valves of vacuum cylinder are positively operated by means of eccentrics, and the speed of the machine is only limited by the conditions limiting the speed of o dinary steam engines. The ordinary running speed of these machines is 100 revolutions per minute (for 18 inch stroke or less) and can be exceeded, depending upon length of stroke and the size of the machine. The fly-wheels are proportioned for a speed less than 100 revolutions per minute and the lower speeds may be obtained by adjusting the governor to the speed required. As no water is admitted to the inside of the vacuum cylinders no difficulty is encountered in removing it at the end of stroke, thus admitting of high rotative speed, while most rotative dry vacuum pumps of other manufacturers employing the ordinary suction a· d delivery valves, require water injected inside the vacuum cylinders to keep the cylinders cool and to seal the valves, thus requiring these pumps to run at a slow rate of speed so that the water can be discharged as the pump approaches the end of its stroke. The result is that a machine has to be employed practically double the size required if one of our rotative dry vacuum pumps, with mechanically operated suction valves is used

For high steam pressures we provide the steam cylinders with Meyer cut-off valves, at extra price, producing a high economy in steam consumption.

The type of suction valves employed in the vacuum cylinders depends upon the size of cylinders. The smaller machines have valves of the slide valve type and the larger machines rotary va'ves of the Corliss type. The ports are of very liberal size so as to offer the least p ssible friction to the vapors handled. The suction valves, being mechanically moved, open promptly to the full extent and offer no obstruction to the entrance of the vapors into the vacuum cylinders, instead of compelling the vapor to overcome the tension of the suction valve springs before the suction valves can open, as in the ordinary type of vacuum pump. The design of the valves in the vacuum cylinders is such that all vapor remaining in the clearance space, at the end of the stroke of the vacuum piston is removed by means of an equalizing port in the valve, which connects the two opposite ends of the vacuum cylinder together when the piston is at the end of its stroke. The result of this is, that the vapors collected in the clearance space in front of the piston at atmospheric pressure, pass back into the large vacuum space at the back of the piston, the pressure on the two sides of the vacuum piston being thus equalized and reduced to very nearly that maintained in the suction pipe, so that when the piston begins to make its return stroke, instead of the clearance space being filled with vapor at atmospheric pressure, which would expand and prevent the immediate production of a complete vacuum, work begins at once and practically the full displacement of the vacuum, piston is effective at each stroke.

One of the most important features of this machine is that, although it may be run at constant speed, the steam consumption in driving it is in proportion to the work done. The steam and vacuum cylinders are made of close grained cast iron, as hard as can be machined. Steam and vacuum pistons are of cast iron, with packing rings, and both pistons are machined on the outside. The connecting rods are of best open hearth forged steel, arranged with special adjustments. The steam valves are of the common D type, fitted with Meyer cut-off when specially ordered. In this case the steam valve consists of two parts, the main and distributing valves. When the Meyer cut-off is used, the point of cut-off is indicated by a pointer and scale, and the point of cut-off is adjusted by means of a hand wheel. The valve gear is a modification of the eccentric motion giving a quicker movement of the valves than is possible with the ordinary eccentric motion. The beds of both the single and duplex types are designed to resist and withstand the severest strains. The main bearings have broad surfaces, with adjustments for taking up wear, and are heavily babbitted. The quality of material and workmanship employed on these machines is of the best, and everything is subjected to a rigid test and inspection under conditions as nearly approaching the working conditions as possible, before leaving the factory.

Every machine is provided with centrifugal speed governor, and with oiling device.

For illustrations see pages 32 and 34. For sizes see page 35.

VERTICAL POWER AIR COMPRESSOR—STYLE V.

TRIPLEX TYPE.

Vertical Power Air Compressors.

Style V.

For moderate pressures and large capacaties, the machine shown on the opposite page will be found most desirable, owing to its great rigidity, positive action, and consequent freedom from breakdowns.

The crank shaft being in the base of the machine, all vibration due to revolving parts is absorbed by the foundation.

The supports for the cylinders are conical-shaped columns with proper openings for access to moving parts, and make a most substantial support for the cylinders. They are accurately bored for the crosshead guides. The crank shaft is a steel forging of ample size, supported in babbitted bearings having wedge adjustments. The air valves are positive in their action, and are driven by eccentrics from the shaft. They are supplied with special relief ports for exhausting the air remaining in the clearance spaces around to the opposite side of the piston, thus insuring the piston drawing in a complete cylinderful of air during the next stroke. The crosshead is of a strong box form, with adjustable babbitted shoes. The connecting rods have wedge adjustments in the boxes, and the crank ends on the triplex type are provided with straps and keys.

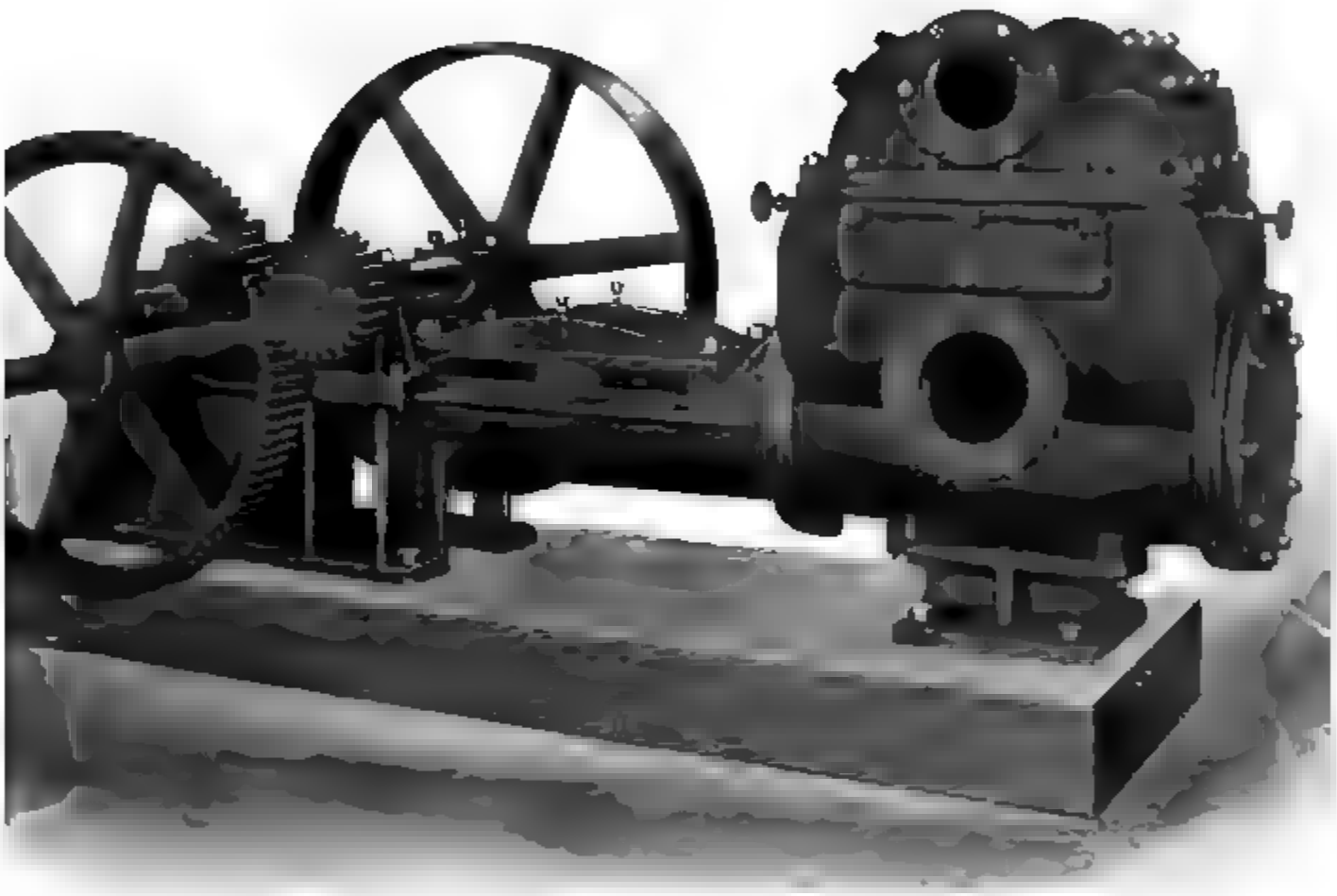
This machine is made as a triplex (as shown), as a duplex or as a single cylinder compressor. In the duplex form, two cylinders are used, one on either side of the pulley. In the single form, one cylinder is used, with an outboard bearing for the end of the shaft, the pulley being between the cylinder and this outboard bearing. Suitable oil cups are provided for all wearing parts, the system of oiling being very complete. Multiple sight feed cups are used, with pipes leading to the various points requiring oil. These machines are designed for a working pressure of 15 pounds per square inch, but we are prepared to build, at short notice, machines of this class for pressures up to 50 pounds per square inch.

These machines are to be prefered to the horizontal type where floor space is limited.

VERTICAL POWER AIR COMPRESSOR OR
VACUUM PUMP—STYLE W.

TRIPLEX TYPE

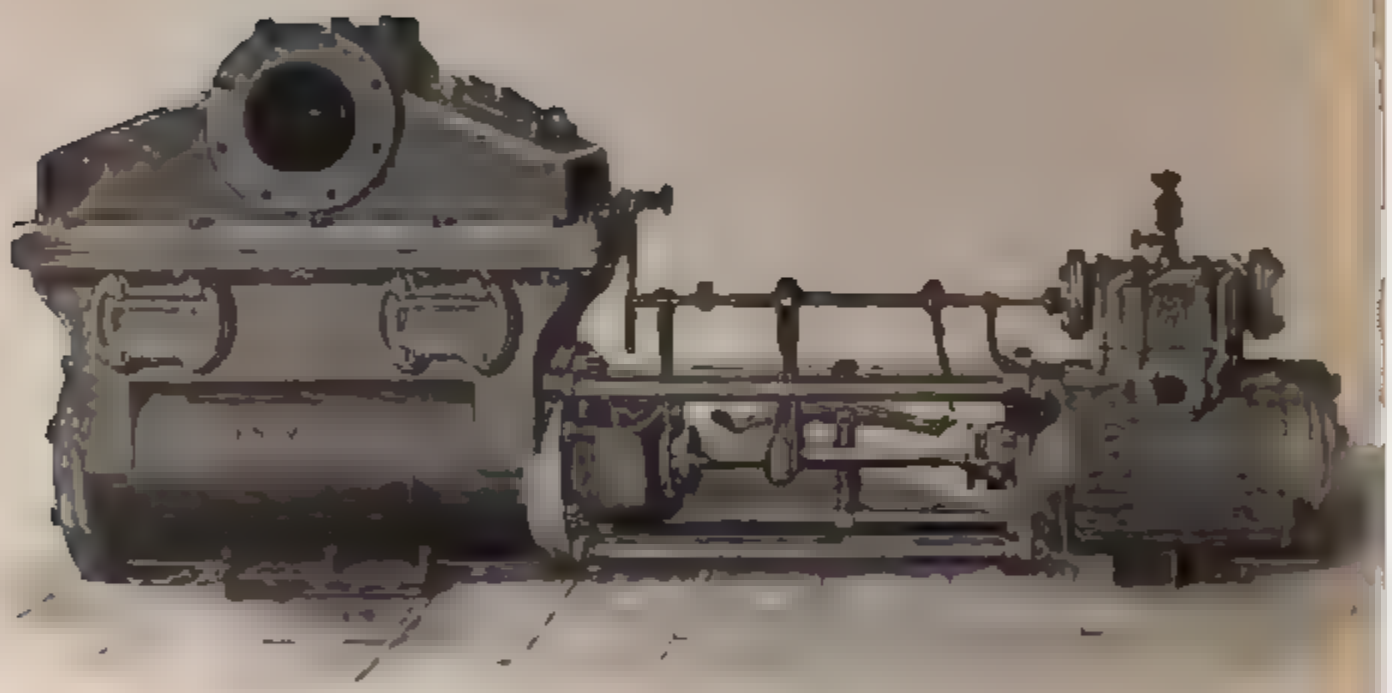
Prices on Application.



KNOWLES HORIZONTAL POWER VACUUM PUMP.

Belted Pump. Double-Acting Single Cylinder Pattern.

Prices on Application.



KNOWLES PATENT VACUUM PUMP.

DIRECT ACTING. PATTERN.

[redacted]

KNOWLES PATENT
VACUUM PUMPS.

Direct-Acting Pattern.

FOR use in sugar refineries, plantation sugar houses, for condensed milk factories, glue factories, and for all kinds of apparatus used in concentrating extracts, chemicals, etc., these Improved Direct-Acting Vacuum Pumps are especially adapted. They combine all the latest improvements, and are simple, compact and very reliable. The workmanship and materials used in their construction is of the *best* character. Durability and freedom from accident or expensive repairs, are prominent features They occupy but little room and do not require expensive foundations, being self-contained. They can be transported without being taken apart, and there is but little expense necessary to connect them. They are adapted equally well to the "dry" as to the "wet" system, and will maintain a first class vacuum.

SIZES AND PRICES.

Steam Cylinder. Inches.	Air Cylinder. Inches.	Stroke. Inches.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipe. Inches.	Delivery Pipe. Inches.	Price.	REMARKS.
4	5	7	½	¾	3	3		
6	8	12	¾	1	5	5		
7	10	10	1	1¼	5	5		
8	10	12	1	1¼	6	6		
8	11	12	1	1¼	6	6		
10	12	16	1¼	1½	7	7		
10	14	16	1¼	1½	8	8		
12	16	16	2	2½	8	8		
14	18	24	2½	3	8	8		
16	20	24	2½	3	10	10		
16	22	24	2½	3	10	10		
18	24	24	3½	4	14	14		

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

The valve seats, valve bolts, lining, piston rod of the air cylinder are made of the best gun-metal composition. On the inside head of the air cylinder is provided a water-basin arranged so that the main stuffing-box is always sealed with water, thus preventing any possible leak of air through the gland to deteriorate the vacuum when the pump is in operation.

DOUBLE VACUUM PUMPS.

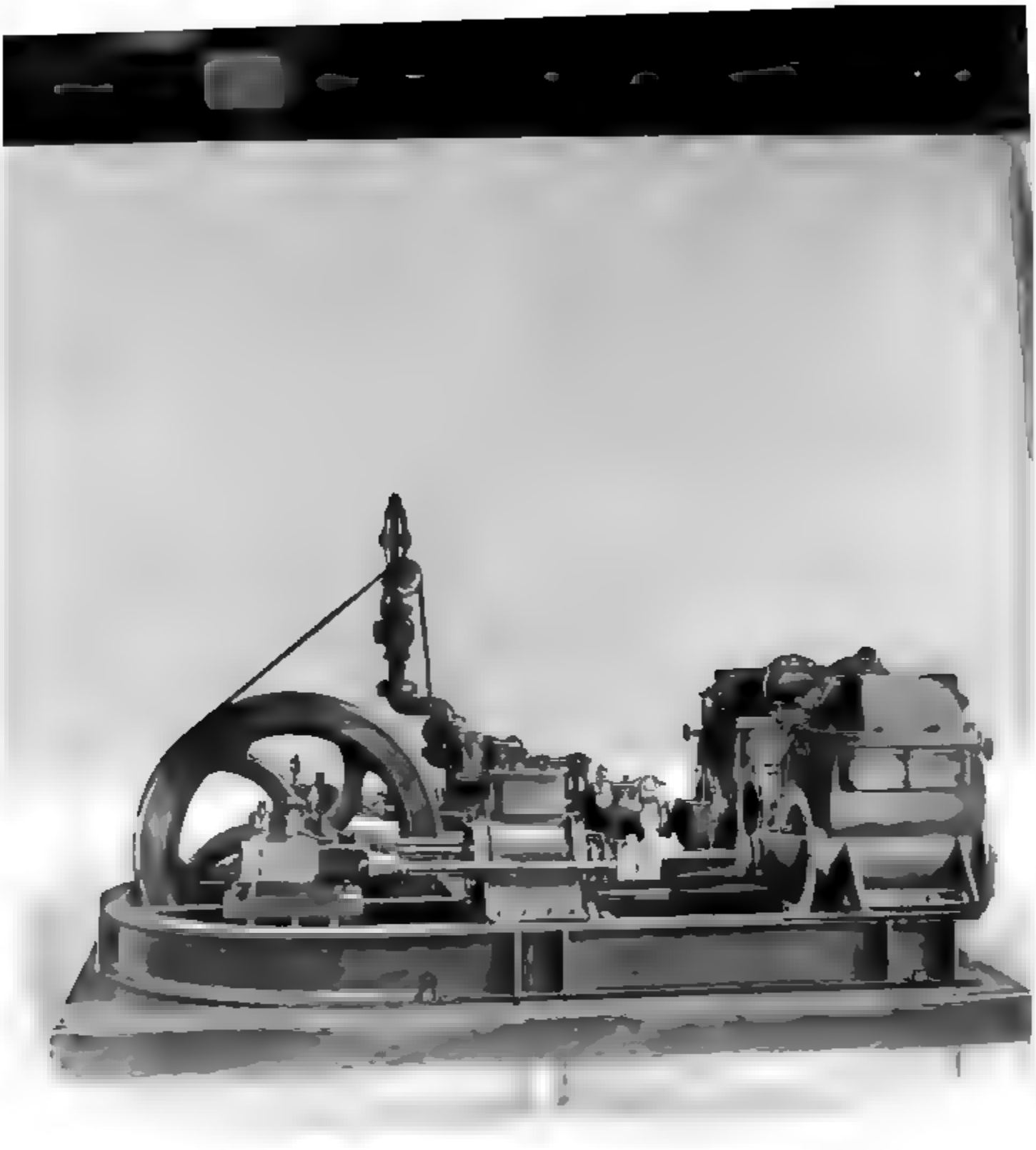
These pumps have two air cylinders, arranged with the steam cylinder between them. The pumps are adapted particularly for "double" or "triple effects," where one air cylinder is connected with the condenser of the "strike" pan, and the other air cylinder to the condenser of the last pan of the "double" or "triple effect."

SIZES AND PRICES:

Steam Cylinder. Inches.	Air Cylinder For Strike Pan Condenser. Inches.	Air Cylinder for "Effect" Condenser. Inches.	Stroke. Inches.	Steam Pipe. Inches.	Exhaust Pipe. Inches.	Suction Pipes. Inches.	Delivery Pipes. Inches.	Price.
18	16	16	16	2½	3	8	8	
20	18	18	24	3½	4	8	8	
22	20	20	24	4	4½	10	10	
24	22	22	24	4	4½	10	10	
26	24	24	24	4	4½	12	12	

ALSO PATTERNS FOR SMALLER AND LARGER SIZES OR OTHER COMBINATIONS OF CYLINDERS.

The air cylinders have gun-metal composition linings, valve seats, valve bolts, piston rod. The arrangement of water-basins for sealing the air cylinder stuffing-boxes are the same as in the above.



KNOWLES IMPROVED DUPLEX FLY-WHEEL VACUUM PUMP.

Size, 10x16x10.

[redacted]

KNOWLES IMPROVED
DUPLEX FLY-WHEEL VACUUM PUMP.

THE cut on the opposite page shows our latest pattern Duplex Fly-Wheel Vacuum Pump. Owing to their perfectly uniform and positive length of stroke and consequent small clearance space in both steam and vacuum cylinders, these pumps are most efficient, both in producing high vacuum and in economy in steam consumption.

They are made in th most thorough manner and of the best materials. The Air Cylinders are lined with gun-metal composition. The piston rods, valve seats, and valve bolts are also of composition. The pistons of the Air Cylinders are of composition, packed with a special form of adjustable packing. The steam cylinders have plain D slide valves. The connecting rods, crossheads, and crank shaft are of the best forged iron. Each and every detail is carefully designed and adjusted for the best service. The cranks are set at right angles, consequently there is no "*dead centre*" and the motion is steady and uniform at any speed.

The design of our new pattern vacuum cylinder is such that the same pump may be used equally well for either the wet or dry system.

In the "wet system," all the water used for condensing passes through the pump, while in the "Dry System," the "Barometrical column" or leg pipe carries off the injection water by gravity from the bottom of the condenser without passing through the pump.

LIST OF SIZES, ETC.

Steam Cylinder.	Vacuum Cylinder.	Stroke	Steam Pipe.	Exhaust Pipe.	Suction Pipe.	Discharge Pipe	Length.	Width.	Height.	Telegraphic Code Word.
5	6	6	1	1¼	5	5	85	45	40	Feague
6	8	6	1	1½	5	5	90	48½	40	Fealty
7	10	6	1¼	2	6	6	95	50¾	42	Fearful
8	10	6	1¼	2	6	6	95	51¾	45	Fearless
8	10	10	1½	2½	6	6	128¼	60	56	Feaster
8	12	10	1½	2½	6	6	128¼	60	50	Feasting
8	14	10	1½	2½	8	6	134	64	54	Feathered
9	12	10	1½	2½	6	6	128¼	60	60	Feathery
9	14	10	1½	2½	8	6	132½	67	51	Featness
10	14	10	1½	2½	8	6	132½	67	63	Featured
10	16	10	2	3	10	8	136	82½	47	Feaze
12	16	10	2	3	10	8	136	82½	47	Febrific
12	18	10	2	3	12	10	136	82½	47	Febrifuge
12	20	10	2	3	12	10	154	101	51	Febrile
14	18	10	2	3	12	10	136	82½	54	Fecial
14	20	10	2	3	12	10	154	101	44	Fecula
14	22	10	2	3	12	10	136	80½	44	Feculent
16	22	10	2½	3½	12	10	151¼	80½	55	Fecund
18	24	10	2½	4	12	10	172½	92½	44	Fecundate

ALSO LARGER SIZES AND OTHER COMBINATIONS OF CYLINDERS.

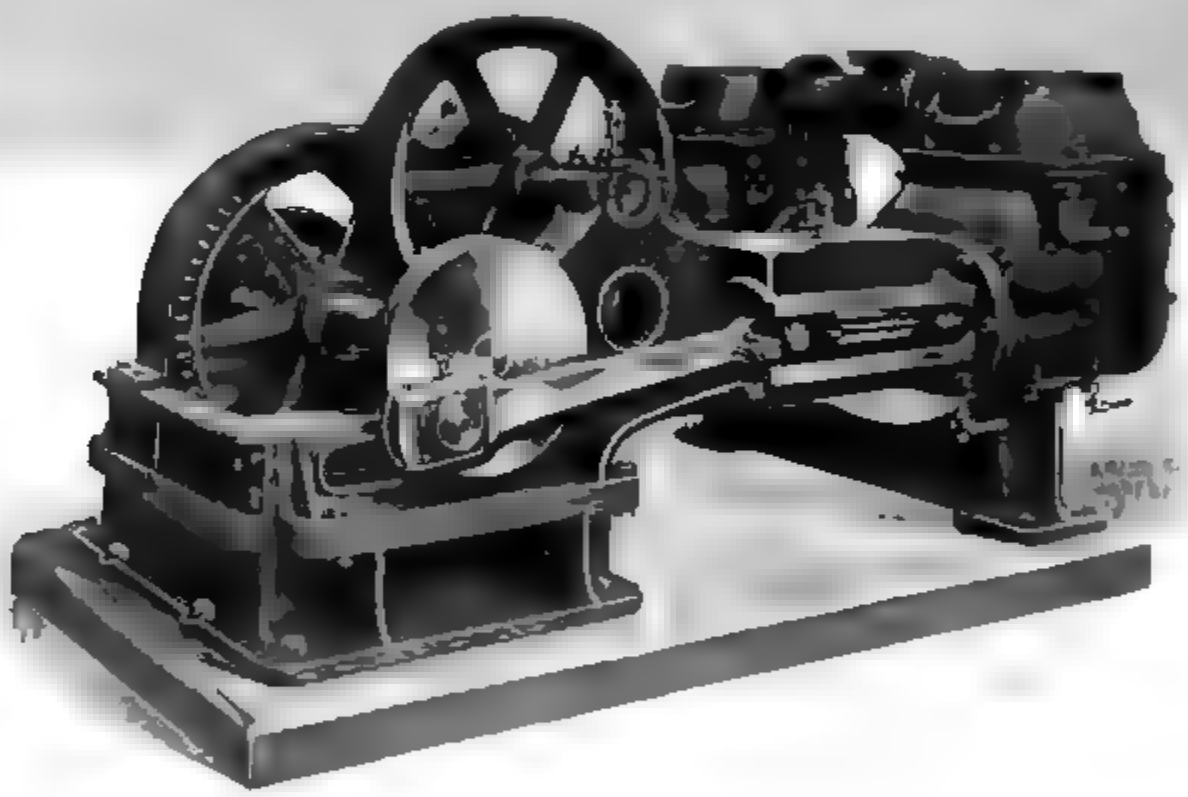
The Governor shown in the cut is supplied only when ordered—at a slight additional expense.

☞ **Parties Ordering** will please inform us (1) if the vacuum pump is for "Wet" or "Dry" System and (2) what is the diameter of the Pan or Evaporator and the amount of heating surface in same; (3) what is the character of the material and quantity to be evaporated per hour in the evaporator; and (4) the average temperature of the injection water *for the condenser.*

KNOWLES HORIZONTAL DUPLEX POWER VACUUM PUMP

FOR VACUUM PAN SERVICE.

Belted Pump. Double-Acting Piston Pattern.



SIZE 10X10.

Gear Guard furnished only when specially ordered, and at additional price.

[redacted]

Knowles Horizontal Duplex Power Vacuum Pumps.

For Vacuum Pan Service.

Double-Acting Piston Pattern.

THE cut of a 10 x 12 Duplex Power Vacuum Pump, as sometimes built without basin heads, is shown on opposite page. Basin heads, however, are usually furnished. These consist of protruding water basins on inside cylinder heads, which surround and seal the stuffing-boxes, thus preventing leakage of air through the gland to impair the vacuum when the pump is in operation. Tight and loose pulleys are usually furnished as shown by outline drawing. The perfectly uniform and positive length of stroke, with the consequent small clearance in vacuum cylinders, make this class of pumps most efficient in producing high vacuum. Pumps of this design may be used on either the "wet system," where all water used for condensing passes through the pump, or on the "dry system," where the "barometrical column" or leg pipe carries off the injection water by gravity from the bottom of the condenser without passing through the pump. These pumps are usually run in sugar houses by countershaft or by belt from motor, but can be furnished with gearing to connect directly with motor for special inquiries, for which we will be pleased to give special figures.

Points of construction:—Close clearance vacuum cylinders with composition linings, composition pistons with adjustable packing, composition piston rods, valve seats and bolts, steel connecting rods, machine cut gears, cranks at right angles, adjustment for all wearing parts, and best material. Gear guard shown in cut not furnished unless ordered, at additional price. When ordering please inform us (1) if the vacuum pump is for "wet" or "dry" system, (2) diameter of pan or evaporator and amount of heating surface in same, (3) character of material and quantity to be evaporated per hour in the evaporator, and (4) average temperature of the injection water for the condenser.

Diameter of Cylinder.	Stroke.	Pulleys, Tight and Loose. Diam.	Face.	Suction.	Discharge.	Ratio of Gears	Dimensions Over All. A	B	C	Telegraphic Code Word.
6	6	20	4	5	5	3.75 to 1	3' 1"	4' 0"	6' 10"	Malava
8	6	26	4	5	5	3.75 to 1	3' 1"	4' 0"	6' 10"	Malavudo
8	10	30	5	5	5	3.75 to 1	4' 1"	4' 5"	7' 10"	Malavise
10	6	30	5	5	6	3.75 to 1	3' 4"	5' 1"	8' 10"	Malaxabt
10	10	30	6	6	6	3.75 to 1	4' 1"	5' 2"	7' 10"	Malaxabunt
12	10	36	6½	6	6	3.75 to 1	4' 1"	5' 3"	7' 10"	Malaxage
14	10	48	6¾	8	6	3.75 to 1	4' 5"	5' 5"	7' 10"	Malaxamus
16	10	36	6½	10	8	5 to 1	4' 3"	5' 5"	7' 10"	Malaxandoa
18	10	36	6¾	12	10	5 to 1	4' 10"	6' 7"	9' 6"	Malaxarent
20	10	48	8¾	12	10	5 to 1	4' 10"	7' 4"	10' 0"	Malaxation
22	10	43	10	12	10	5 to 1	5' 3"	8' 0"	10' 6"	Malaxatura
24	10	48	1	12	10	5 to 1	5' 6"	8' 0"	10' 8"	Malaxavero

KNOWLES HORIZONTAL DUPLEX POWER SYRUP PUMP.

Belted Pump Double-Acting Piston Pattern.

SIZE 10x10.

Gear Guard furnished only when specially ordered, and at additional price.

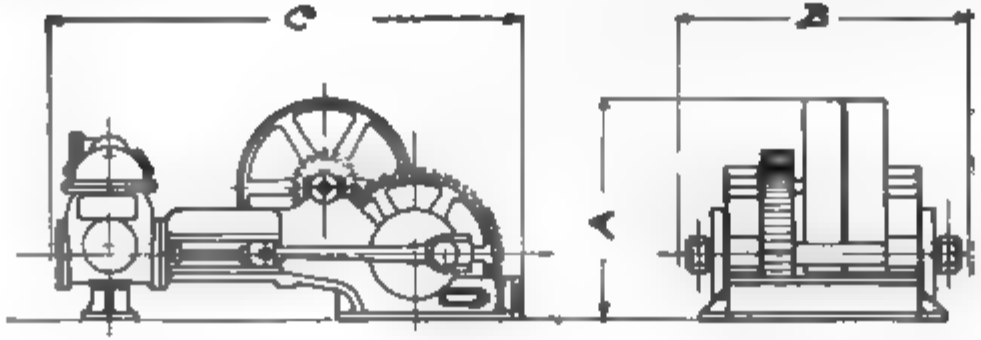
Knowles Horizontal Duplex Power "Sweet Water" Pumps

and

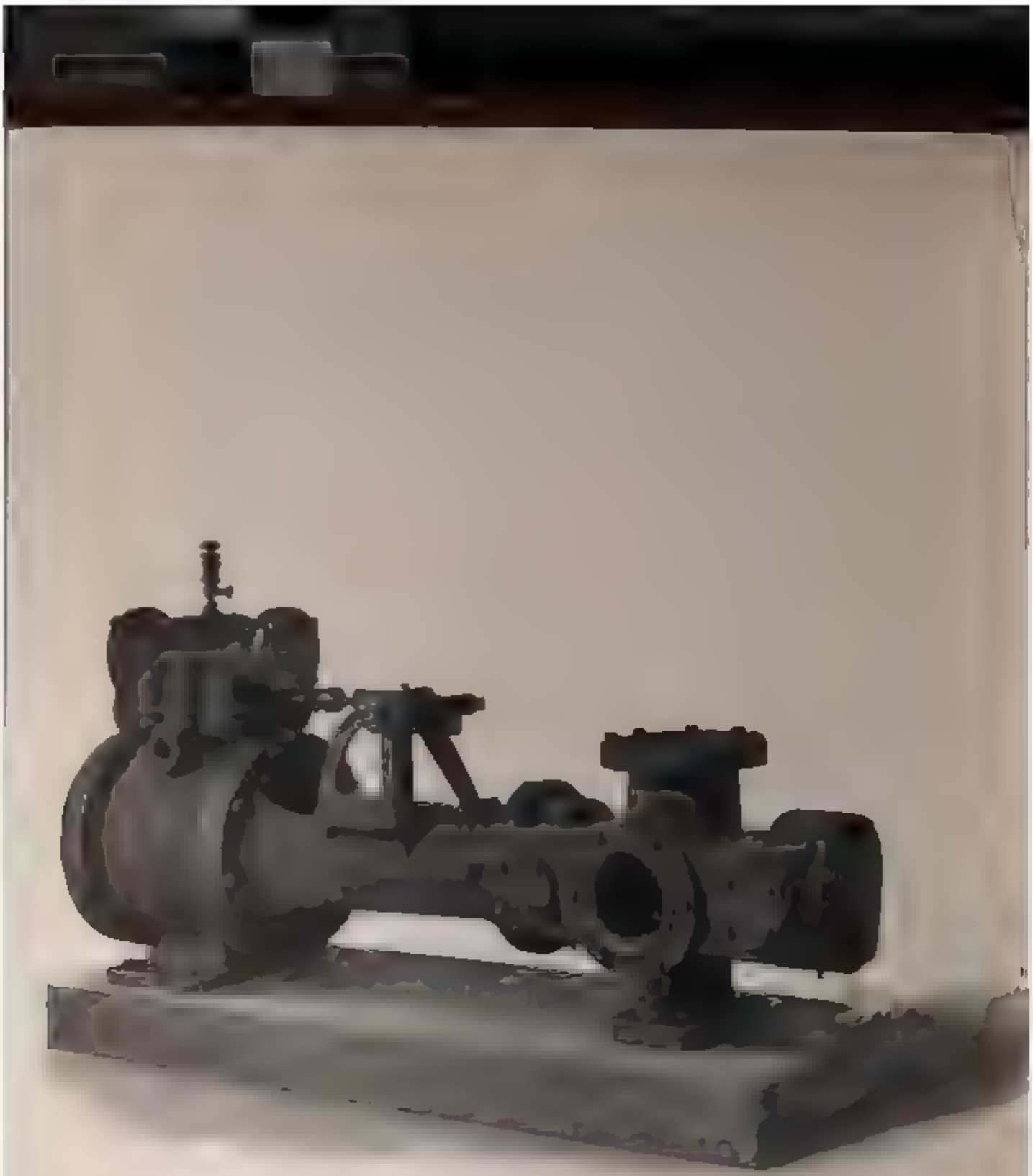
Horizontal Duplex Power Syrup Pumps,

Double-Acting Piston Pattern.

THE cut opposite represents a 10 x 10 duplex power syrup pump, and the same pump with air chamber left off is used for "sweet water." On both pumps tight and loose pulleys are furnished as shown by outline drawing. The syrup pump, which is usually located 20 to 35 feet below pan, is arranged to pump the hot syrup from the pans, which are under a vacuum of 26 to 28 inches the pump delivering the syrup against a head of 25 to 30 feet. The "sweet water" pumps are especially designed for removing the "sweet water" condensed in the heating drums or coils of a double or multiple effect, and pull a vacuum therein of 12 to 20 inches, discharging into an open pipe or drain. No air chamber is used, as shown by outline drawing. Both pumps have cylinders of the "close-clearance" type with composition linings, composition pistons, piston rods, valve seats and bolts, steel connecting rods, machine-cut gears, cranks at right angles, and adjustment for all wearing parts. In sugar houses, both types are generally run by countershaft, or by belt from motor, but can be furnished direct connected to motor by gears. When so arranged we prefer to give special figures for same. Gear guard, shown in cut, not furnished unless specially ordered, at additional price.



Diameter of Cylinders.	Stroke.	Pulleys, Tight and Loose. "Sweet Water." Diam.	Face	Syrup Diam.	Face.	Suction	Discharge	Ratio of Gears	Dimensions Over All for "Sweet Water" Pumps. A	B	C	Dimensions Over All for Syrup Pumps. A	B	C	Telegraphic Code Word. "Sweet Water" Pumps.	Syrup Pumps.
6	6	20	4	20	5	5	5	3.75 to 1	2' 6"	4' 6"	6' 2"	4' 6"	4' 8"	6' 2"	Malbarato	Malcham
8	6	26	4	26	6	[illegible]	5	3.75 to 1	3' 6"	4' 6"	6' 2"	4' 9"	4' 10"	6' 2"	Malbarer	Malchance
8	10	30	5	30	6	6	5	3.75 to 1	3' 2"	4' 8"	7' 2"	4' 9"	4' 10"	7' 2"	Malbeck	Malchiah
10	6	30	5	30	[illegible]	[illegible]	[illegible]	3.75 to 1	3' 4"	5' 6"	6' 2"	5' 6"	5' 2"	6' 2"	Malblad	Malchion
10	10	30	6	36	[illegible]	8	[illegible]	3.75 to 1	3' 4"	5' 2"	7' 2"	5' 6"	5' 4"	7' 2"	Malbladen	Malchiram
12	10	36	6½	48	[illegible]	10	8	3.75 to 1	3' 10"	5' 3"	7' 2"	6' 2"	5' 4"	7' 2"	Malbroeken	Malcolmie
14	10	40	6½	48	10	[illegible]	8	3.75 to 1	4' 0"	5' 5"	7' 2"	6' 4"	6' 0"	7' 2"	Malbrouk	Malcomias
16	10	36	6½	48	12	12	10	3.75 to 1	4' 2"	5' 7"	7' 2"	7' 2"	6' 0"	7' 2"	Malcasado	Malcomido



THE KNOWLES MAGMA PUMP.

Size, 16 x 7 x 12.

THE KNOWLES "MAGMA" PUMP.

THE Knowles "Magma" Pump is illustrated on the opposite page. This pump is largely used in sugar houses to move the thick semi-fluids which require to be handled in connection with such work. For such service it is important that the pump be made with extra large passageways for the liquid, and with the smallest possible number of working parts in the pump cylinder. To meet these requirements the Knowles "Magma" pump is constructed with a large suction opening, usually larger than the pump cylinder bore, opening downward directly into the centre of the pump cylinder. There are no suction valves in the pump. The pump piston travels across the large suction inlet, and after this opening is closed, all the material remaining between the pump piston and the cylinder head is expelled through a special form of discharge valve arranged to give a particularly large and free opening. With this type of pump it is essential that the liquid handled should flow to the pump under a head.

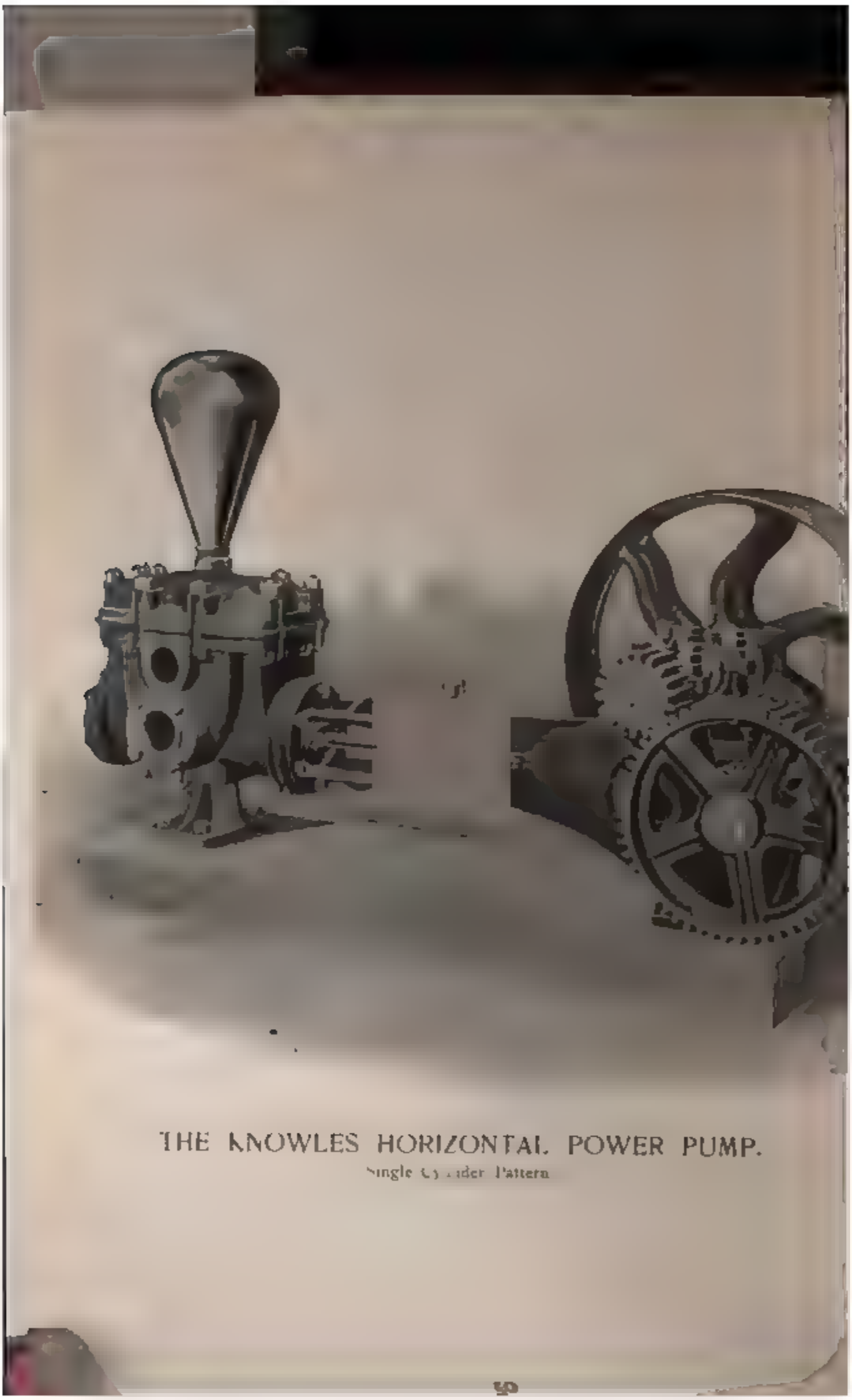
The same features that render this pump so particularly desirable for sugar house work, make it equally suitable for handling any other semi-fluid material. It will successfully pump soap, whitelead, printer's ink, tar, etc , etc.

Steam Cylinder	Pump Cylinder	Stroke	Steam	Exhaust	Suction	Discharge	Telegraphic Code Word.
6	5	12	¾	1	6	5	Icelle
8	5	10	1	1½	6	5	Icelos
8	5	12	1	1½	6	5	Icenes
8	6	12	1	1½	7	6	Icequake
10	6	12	1¼	1½	7	6	Icerimus
10	7	12	1¼	1½	8	7	Icerunt
10	8	12	1¼	1½	10	8	Icespar
12	6	12	1½	2½	7	6	Ichabod
12	7	12	1½	2½	8	7	Ichnanthe
12	8	12	1½	2½	10	8	Ichnestome
14	7	12	2	3	8	7	Ichneumia
14	8	12	2	3	10	8	Ichneumon
16	7	12	2	3	8	7	Ichneute
16	8	12	2	3	10	8	Ichnobates
14	10	18	2	3	12	10	Ichnode
18	10	18	2½	3½	12	10	Ichnolite
20	10	18	3	4	12	10	Ichnology
18	10	24	2½	3½	12	10	Ichnusa
20	10	24	3	4	12	10	Ichonuphis

TAIL PUMPS.

We also have patterns for "Tail Pumps" similar in design to the above, used for removing the material from triple effect or evaporators. As these pumps have to work against a vacuum on the suction, they are fitted with basin heads, with "drowned" stuffing boxes on the pump ends. Each pump has *two* discharge openings.

Steam Cylinder	Pump Cylinder	Stroke	Steam	Exhaust	Suction	Discharge	Telegraphic Code Word
5½	4	12	½	¾	3	1¼	Icoglan
6	5	12	¾	1	3	1½	Icolmkill
8	6	12	1	1⅛	4	2	Iconibus
8	7	12	1	1½	4	3	Iconiche



THE KNOWLES HORIZONTAL POWER PUMP.

Single Cylinder Pattern.

THE KNOWLES

HORIZONTAL POWER PUMP.

SINGLE CYLINDER PATTERN.

THE cut on opposite page shows one of our improved power pumps, Double Acting Single Cylinder pattern, fitted with gears. We also make the same pump designed to drive directly by belt, without intermediate gearing. This style of pump has suction and discharge valves above the cylinder barrel, and is designed to stand a water pressure of 100 pounds per square inch. Adjustments are provided, so that wear can be taken up in all bearings, slides, and other parts subject to wear. Every part is carefully proportioned, and material and workmanship are of the best. All gears and pinions have machine cut teeth.

The best gun metal composition is used in the linings, valve seats, **and pistons**, the latter being suitably packed for hot or cold water or other liquids.

Heavy balance wheels are provided for all sizes.

The capacities in the table below are figured at the moderate speed of 80 feet piston travel per minute; this can be increased if desired.

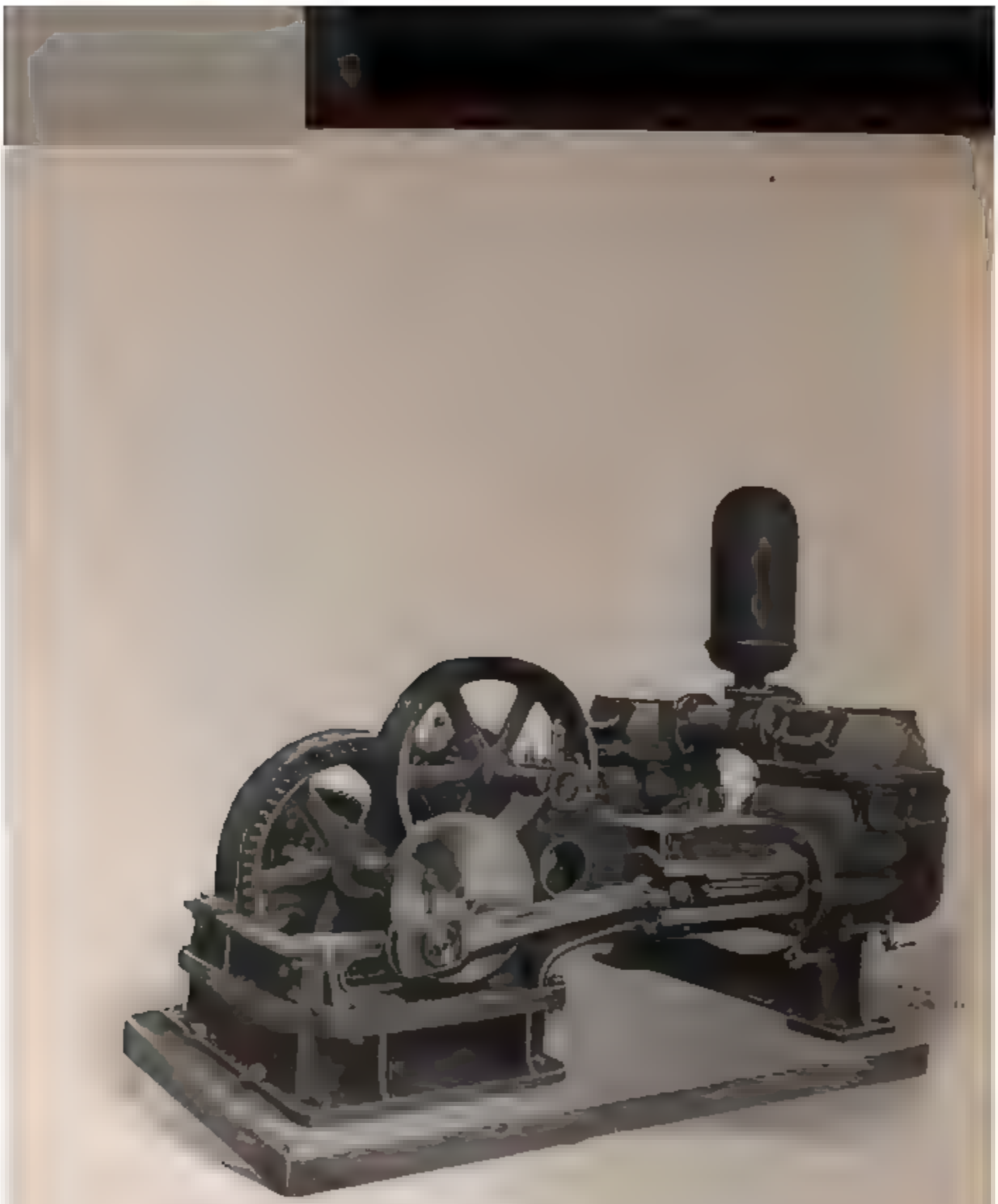
We have patterns also for power pumps arranged with *inside or outside plungers*, **suitable for gritty or bad water.**

When sending inquiries or orders, always state the pressure against which pump will have to work.

SIZES AND CAPACITIES

Diameter of Piston.	Stroke.	Gallons per Revolution.	Gallons per Minute	Suction	Discharge.	Code Word.	Diameter of Piston	Stroke	Gallons per Revolution.	Gallons per Minute.	Suction.	Discharge	Code Word.
3	6	.36	29	2	1½	Elusion	9	12	6.60	264	6	6	Embalmer
3¼	6	.43	35	2	1½	Elusive	10	12	8.14	326	6	6	Embank
3¾	6	.57	46	2	1½	Elusory	10	16	10.86	326	6	6	Embargo
4	6	.66	52	2½	2	Eluted	10	24	16.32	326	6	6	Embase
3¼	10	.72	35	2½	2	Eluting	12	12	11.74	470	8	6	Embattle
3¾	10	.96	46	2½	2	Eluxate	12	16	15.66	470	8	6	Embay
4⅛	10	1.11	54	3	2½	Elvan	12	24	23.48	470	8	6	Ember
4½	10	1.38	65	3	2½	Elvish	14	16	21.32	640	10	8	Embezzle
5	10	1.70	82	3	2½	Elysian	14	24	32.00	640	10	8	Emblaze
6	12	2.93	117	4	4	Emaciate	16	16	27.84	836	12	10	Emblem
7	12	4.00	160	5	5	Emanate	16	24	41.76	836	12	10	Embody
8	12	5.22	209	5	5	Embale							

ALSO PATTERNS FOR LARGER SIZES OR COMBINATIONS.



THE KNOWLES HORIZONTAL POWER PUMP.

DUPLEX PATTERN

[redacted]

THE KNOWLES HORIZONTAL

DUPLEX POWER PUMP.

PISTON, OR INSIDE PLUNGER PATTERN. GIRDER 97 FRAME.

THE Duplex form of Power Pumps we recommend for water works service, for supplying hydraulic elevators and for such other places as require a very steady or heavy pressure with uniform action. These pumps can be geared directly to the jack shaft of turbine water wheels, or can be driven by belt or gear connection from line shafting run by water or steam power. For hydraulic elevator work they are often driven by gas engines.

These pumps are carefully designed and built with great thoroughness. Each water cylinder is double-acting, and is arranged with lining and valve-seats of composition. The crank-shafts, connecting rods, cross-heads, gears, etc., are well proportioned and made of the very best materials. All bearings, slides, etc., are arranged for taking up wear. The cranks are set at right angles; as shown by the engraving on opposite page, these pumps are arranged with heavy band wheels.

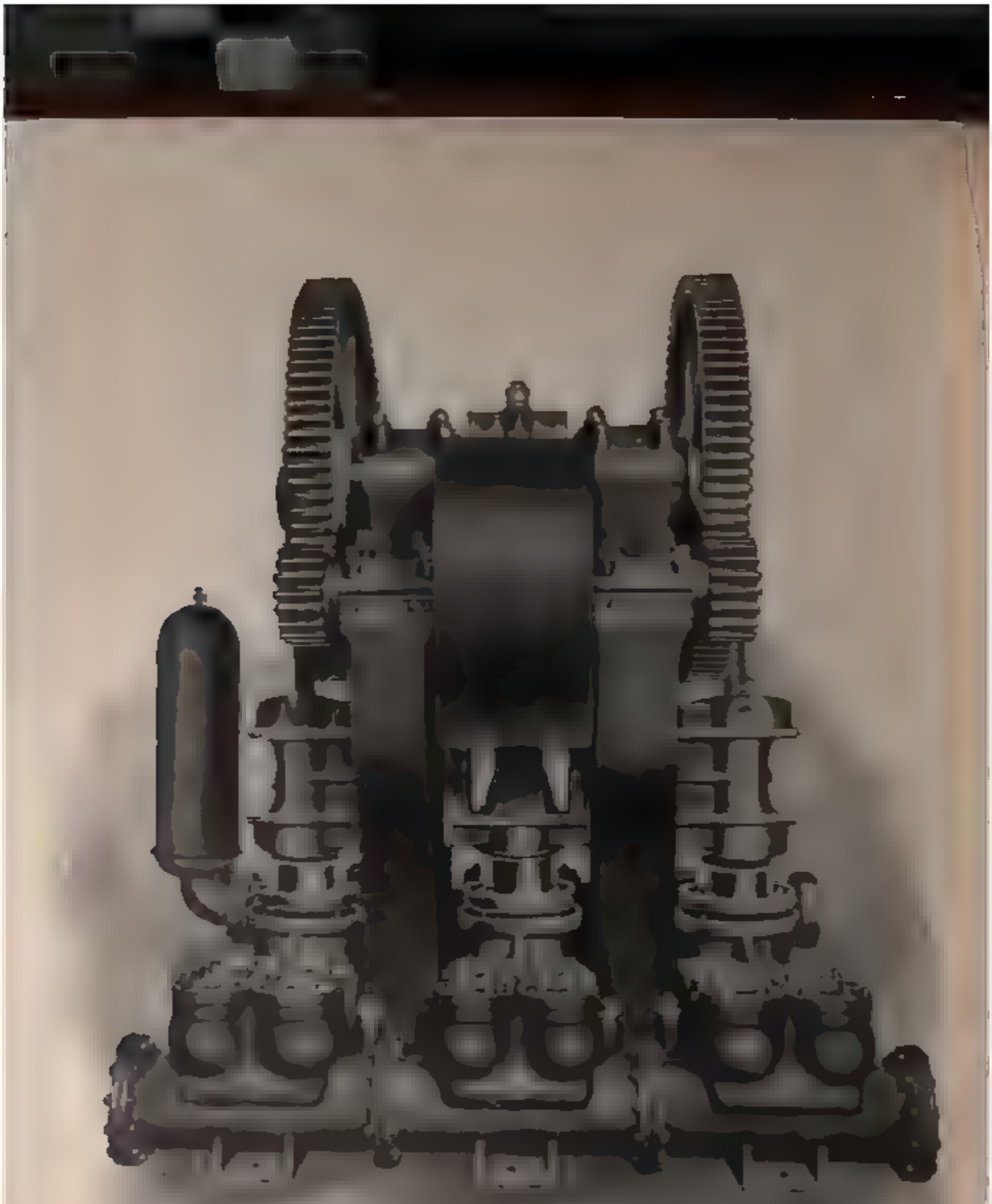
All gears have machine-cut teeth. All sizes in the following list can be made for water pressures as high as 130 pounds per square inch. We have also many patterns for pumps of this type designed for lighter, and for heavier pressures than the above. As the cost of a power pump depends largely upon the pressure it must be suited for, always in sending inquiries or orders state the water pressure pump must develop, as well as the capacity required.

SIZES AND CAPACITIES.

Diameter of Cylinders	Stroke.	Gallons per Revolution (Both Cylinders).	Gallons per Minute.	Suction	Discharge	Code Word	
						Piston Pattern	Inside Plunger Pattern.
3¾	6	1.14	92	3	2	Emphasis	Emulous
4⅛	6	1.39	111	3	2	Emphatic	Emulsion
5½	6	2.47	198	5	4	Empight	Emulsive
5	12	4.08	163	5	4	Empiric	Enable
6	12	5.88	235	5	4	Emporium	Enabling
7	12	8.00	320	6	5	Empower	Enact
8	12	10.44	418	8	6	Empress	Enacting
9	12	13.20	528	10	8	Emprise	Enactive
10	12	16.28	651	10	8	Emption	Enactor
10	18	24.42	651	12	10	Empurple	Enambush
12	12	23.48	940	12	10	Empuse	Enamor
12	18	35.20	940	12	10	Empyema	Enarmed
12	24	46.97	940	14	12	Empyreal	Enate
14	18	48.00	1280	14	12	Emulate	Enaunter
14	24	64.00	1280	14	12	Emule	Encamp
16	18	62.66	1670	16	14	Emulge	Encamped
16	24	83.55	1670	16	14	Emulgent	Encanker

ALSO PATTERNS FOR LARGER SIZES OR OTHER COMBINATIONS

The capacities are figured at moderate speed, namely, 80 feet piston travel per minute. This speed can be increased if desired.



KNOWLES VERTICAL TRIPLEX POWER PUMP—STYLES A. & F.

Cut shows style A, 12x12, with Ball Valves, for Filter Press Service. Belt Driven.
Can also be made with extended bed plate to receive electric motor.

Knowles Vertical Triplex Pumps—Styles A and F.

THE cut on the opposite page shows one of the larger sizes of vertical triplex electric power pumps as it appears with extended bed-plate ready for mounting the motor. In addition to its suitability for boiler feed, hydraulic and general tank service, this pump is especially adapted for mining operations, as it is designed so as to be easily taken apart and readily put together again when necessary. Our experience in mine pumping has enabled us to embody all the essentials in this pump which insure convenience, reliability and compactness. The arrangement of cranks differs from the preceding styles of pumps in having supports for crank shaft between centre and outside cranks. This arrangement produces a smaller bending moment in the crank shaft, and is for this reason better adapted to these pumps of larger capacities. The plungers are single-acting, guided above, relieving them of excessive wear or strain, and packed from the outside, so any leakage may be readily detected. The power is transmitted direct to each of these plungers in the following manner. A countershaft behind the pump transmits the power to spur gears at either end of the pump, driving the two outside plungers by crank pins secured in gears, and at the same time driving the centre or middle plunger through the single throw crank shaft located between the supports. The steel connecting rods have babbitted boxes, made in halves with key adjustment on crank end, crosshead end being solid with brass bushing. The suction and discharge openings are on either side, a very handy arrangement where space is restricted. Each pump is furnished with a discharge air chamber. The extended bed-plate for the electric type is designed especially to receive the specified type and size of motor. A pinion of fibre will be furnished for the armature shaft, so as to reduce the noise to a minimum, if specially ordered, at extra price; otherwise a cast-iron cut pinion will be furnished. All material is of the highest grade, and great care is taken in the test to prove there is no defect. This class of pump is also made when specially ordered, with connecting rods secured to independent crossheads attached to the upper end of plungers, crossheads being fitted with adjustable shoes in guides.

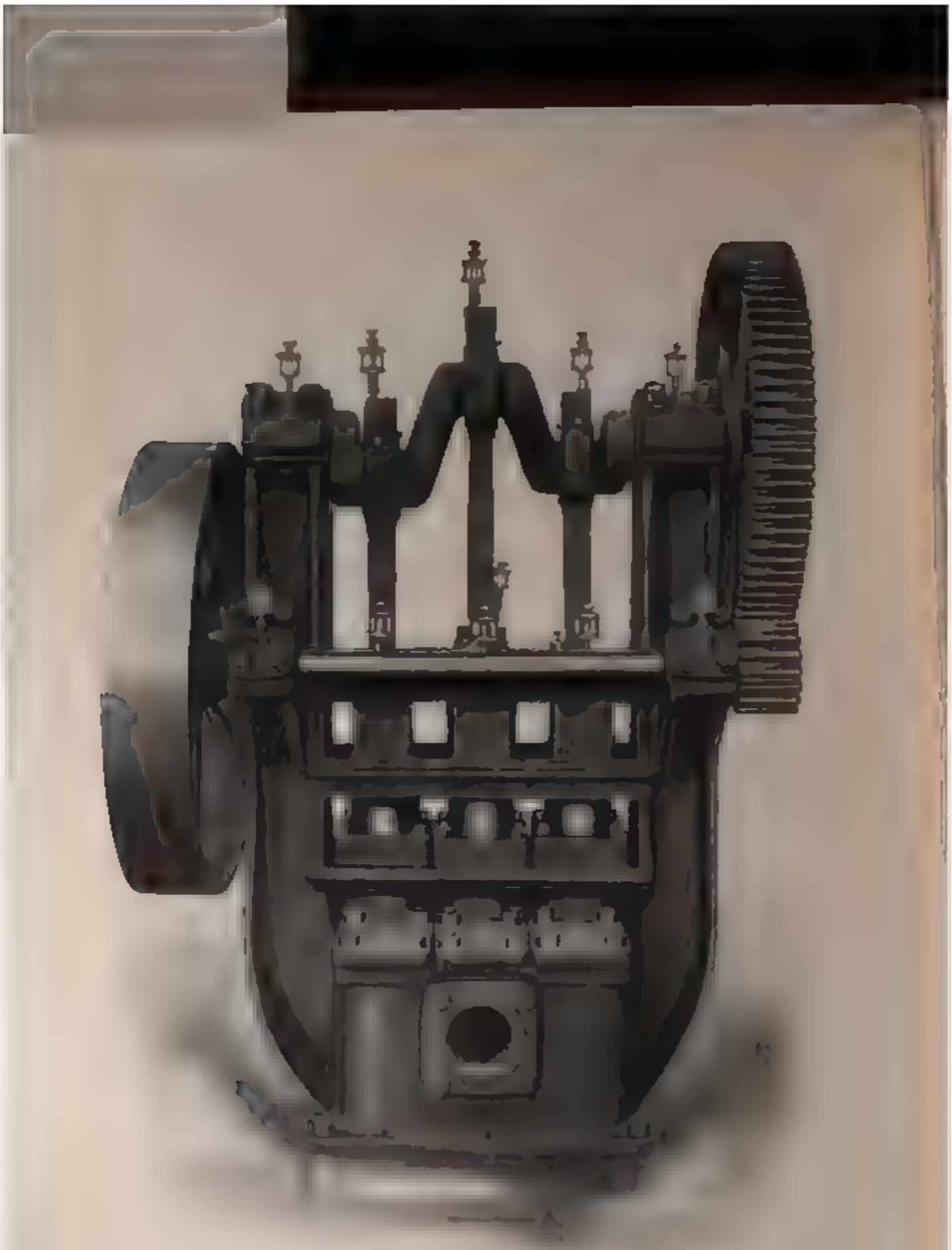
These pumps are designed for two pressures: Upper table, Style A, suitable for 150 pounds water pressure; lower table, Style F, 50 pounds water pressure. In sending inquiries or orders, always state the water pressure.

FOR 100 FEET LIFT, STYLE A

Diameter of Plungers.	Stroke.	Revolutions per Minute.	Gallons per Revolution.	Gallons per Minute.	Suction.	Discharge.	Pulleys Tight and Loose. Diam.	Pulleys Tight and Loose. Face.	Ratio of Pump Gears.	Ratio of Motor Gears.	H. P. Motor Required.	Dimensions Over All Belted Pumps Not Arranged for Motor. A	B	C	Dimensions Over All Arranged for Motor. Geared. A	B	C	Telegraphic Code Word. Belted Pumps Not Arranged for Motor.	Telegraphic Code Word. Electric Pumps. Geared. Arranged for Motor.
8	12	40	7.833	314	5	4	42	6	6 to 1	To Suit Speed of Motor.	30	105	81	88	105	105	95	Dapper	Defeat
9	10	40	8.262	330	6	5	42	6	6 to 1		35	105	81	88	105	108	102	Darkly	Define
9	12	40	9.915	397	6	5	42	8	6 to 1		40	105	81	88	105	108	105	Darling	Deform
10	12	40	12.243	490	8	7	42	8	6 to 1		50	106½	81	93⅞	106½	108	107	Dastard	Defraud
							One Pulley												
11	12	40	14.811	502	8	7	42	10	6 to 1		60	106½	81	93⅞	106½	108	108	Dauber	Deject
12	12	40	17.628	705	10	8	42	10	6 to 1		70	109½	88	97½	109½	115	112	Daunted	Deluge
13	12	40	20.685	827	10	8	42	12	6 to 1		75	109½	88	97½	109½	120	115	Dazzle	Deport

SIZES BELOW ARE FOR 100 FEET LIFT, STYLE F, TIGHT AND LOOSE PULLEYS.

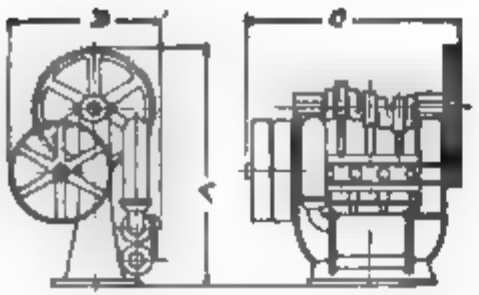
9	10	40	8.262	330	6	5	30	5	5 to 1	To Suit Speed of Motor	18	82	59½	82	82	87	82	Fairly	Faithless
9	12	40	9.915	397	6	5	30	5	5 to 1		20	90	66	87	90	89	89	Fairness	Fakir
10	12	40	12.243	490	8	7	30	6	4.85 to 1		25	95	66	87	95	91	91	Fairy	Falcade
11	12	40	14.811	502	8	7	30	6	4.85 to 1		30	95	66	87	95	95	95	Fairylike	Falcated
12	12	40	17.628	705	10	8	42	8	5 to 1		35	[illegible]	78	96½	101	100	100	Faith	Falchion
13	12	40	20.685	827	10	8	42	8	5 to 1		[illegible]	[illegible]	78	96½	101	105	105	Faithful	Falcon



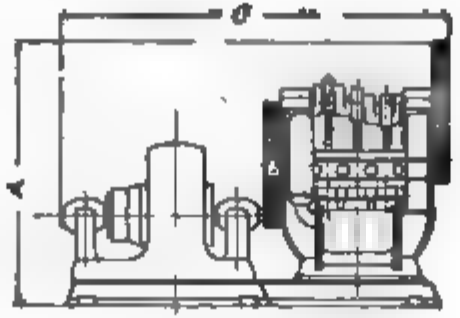
KNOWLES VERTICAL TRIPLEX POWER PUMP.—STYLE C

Cut shows size 5x8 with Ball Valves for Filter Press Service

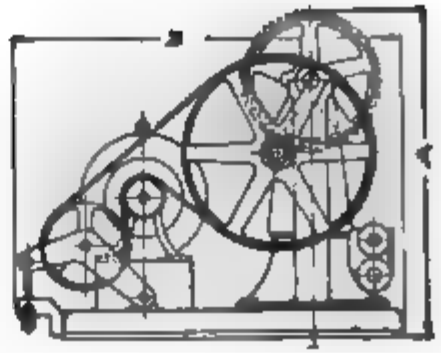
Knowles Vertical Triplex Pumps—Style "C."



Triplex Power Pumps (Belt Driven).
300 ft. Lift Style "C."



Triplex Electric Pumps (Geared).
300 ft Lift Style "C."

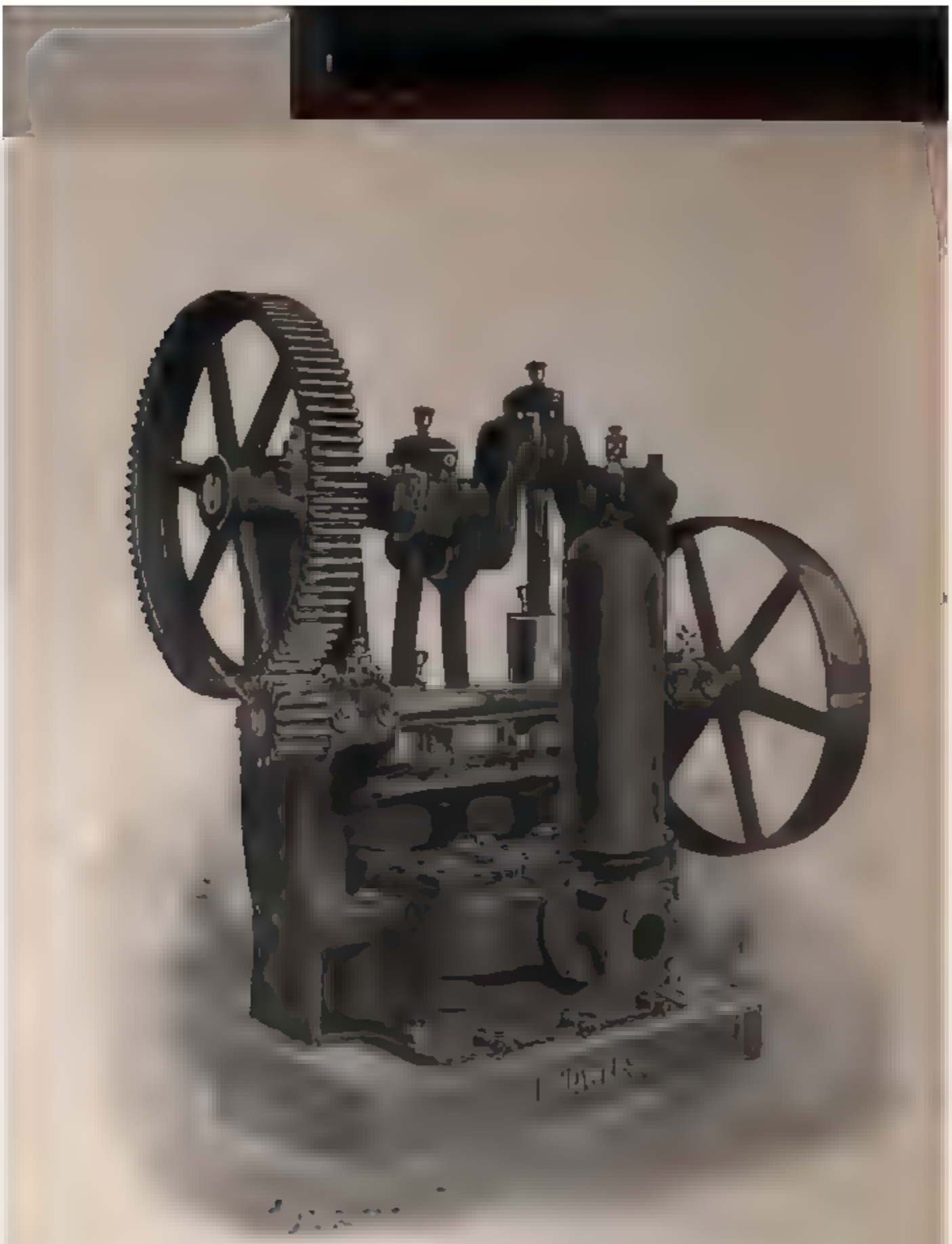


Triplex Electric Pumps (Close Belted).
300 ft. Lift. Style "C."

Diameter of Plungers	Stroke	Revs. per Min.	Gallons per Revolution.	Gallons per Minute	Suction	Discharge	Pulleys, Tight and Loose: Diam	Pulleys, Tight and Loose: Face	Ratio of Pump Gears.	Ratio of Motor Gears. To Suit Speed of Motor	H. P. Motor Required	Dimensions Over All Belted Pumps Not Arranged for Motor: A	B	C	Dimensions Over All, Arranged for Motor Geared: A	B	C	Dimensions Over All, Arranged for Motor, Close Belted: A	B	C	Telegraphic Code Word: Belted Pumps Not Arranged for Motor	Electric Pumps, Geared, Arranged for Motor.	Electric Pumps Close, Belted Arranged for Motor.
2½	4	50	.21	10.40	1½	1½	15	3	5 to 1		1½	32½	18¼	27⅝	34½	29¼	50	35⅛	36⅝	26	Fabian	Facetimore	Macaglie
2¾	4	45	.30	13.78	1½	1½	15	3	5 to 1		3	32½	18¼	31⅜	34½	29¾	54	32¾	43	31	Fabled	Facetious	Macagua
3	4	45	.54	24.48	2	2	20	3	5 to 1		3	43½	25½	38¾	47¾	37	71	47¾	45	39	Fabricate	Facial	Macahalat
3½	6	40	.81	32.63	2	2	20	3	5 to 1		5	43½	25½	38¾	47¾	37	71	47¾	45	39	Fabrile	Facile	Macairien
4	6	40	1.03	41.31	3	3	26	4	5 to 1		7	54	35	46⅞	59	42⅜	82⅝	59	55	41	Fabulate	Facilely	Macairiame
4½	6	40	1.28	51.00	3	3	26	4	5 to 1		7	54	35	46⅞	59	42⅜	82⅝	59	55	41	Fabulist	Facilitate	Macaiste
5	8	40	1.70	68.00	3	3	30	5	5 to 1		10	59	38	49	63⅞	43	85½				Fabulous	Facility	
5½	8	40	2.06	82.23	4	4	30	6	5 to 1		12½	71¾	45½	62¼	76¼	54	106				Fabulously	Facingly	
6	8	40	2.46	97.90	4	4	30	6	5 to 1		15	71¾	43½	62¼	76¾	54	106				Faburden	Fackel	
6½	8	40	2.77	114.93	4	4	30	6	5 to 1		15	71¾	43½	62¼	76¾	54	106				Facade	Faction	
7	8	40	3.33	133.28	4	4	30	6	5 to 1		20	76½	50	71	81½	56	114¾				Facanea	Factional	
8	8	40	4.35	174.07	5	4	36	6	5 to 1		20	76½	52	71	81½	56	114¾				Faceless	Factionary	
8	10	40	5.46	217.50	5	4	42	6	5 to 1		25	81½	55⅞	71¾	88¼	58	115				Faceted	Factious	
9	10	40	6.88	275.40	6	5	42	8	5 to 1		35	85	58	80	90	65	125				Facetely	Mabillon	

SIZES BELOW ARE FOR 160 TO 180 LBS. PRESSURE.

2½	4	40	.17	6.58	1½	1½	15	3	5 to 1		3	32½	18¼	31⅜	34½	29¼	54	32¾	43	31	Faceteness	Mabuja	Macareidis
2¾	4	40	.19	7.67	1½	1½	15	3	5 to 1		3	32½	18¼	31⅜	34½	29¾	54	32¾	43	31	Facetiabor	Macabre	Macarello
3	6	40	.54	21.54	2	2	20	3	5 to 1		5	43½	25½	38¾	47¾	37	71	47¾	45	39	Facetiari	Macacheira	Macarenas
3½	6	40	.81	32.63	3	3	26	4	5 to 1		7	54	35	46⅞	59	42⅜	82⅝	59	55	41	Facetiarum	Macacus	Macareux
4	6	40	1.28	51.01	3	3	30	5	5 to 1		10	59	38	49	63⅞	43	85½	63⅞	56	46	Facetiemur	Macadamize	Macariotes
5	8	40	2.46	97.90	4	4	30	6	5 to 1		20	71¾	43½	62¼	76¼	54	106				Facetieux	Macadanizo	
5½	8	40	3.33	133.28	4	4	36	6	5 to 1		25	76½	52	71	81½	56	114¾				Facetiner	Macadura	
6	8	40	4.35	174.07	5	4	42	6	5 to 1		35	76½	52	71	81½	56	114¾				Faceting	Macagatos	



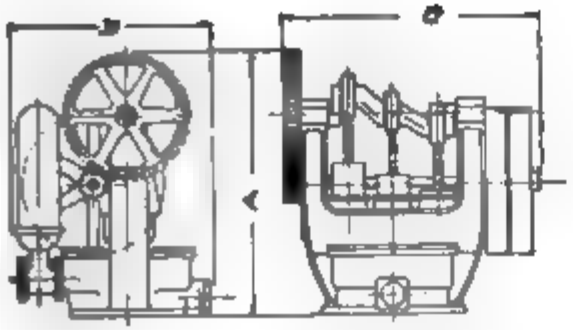
KNOWLES VERTICAL TRIPLEX POWER PUMP—STYLE F.

For Light Service

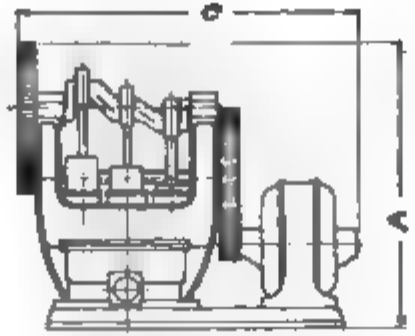
This can be used as a Filter Press Pump.

Knowles Vertical Triplex Pumps – Style E.

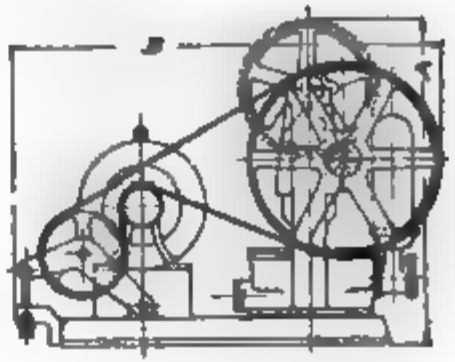
THIS line of power pumps is designed for light service. The plungers are outside packed; the valves can be easily examined. The crank shaft is in one piece, working in babbitted bearings. All gears are cut. Connecting rods have adjustable babbitted boxes secured by keys, and lower ends are held in plungers by steel pins working in brass bushings in the solid ends of the rods. Each pump is furnished with tight and loose pulleys, and discharge air chamber, and has suction and discharge openings on opposite sides. The extended bed-plate for the electric type is designed especially to receive the specified type and size of motor. A pinion of fibre will be furnished for the armature shaft, so as to reduce the noise to a minimum, if specially ordered, at extra price, otherwise a cast-iron cut pinion will be furnished. All material is of the highest grade, and great care is taken in the test to prove there is no defect. The sizes in the following table are suited for 100 ft. lift. In sending inquiries or orders, always state the water pressure.



Triplex Power Pumps (Belt Driven)
100 ft. Lift. Style "E"

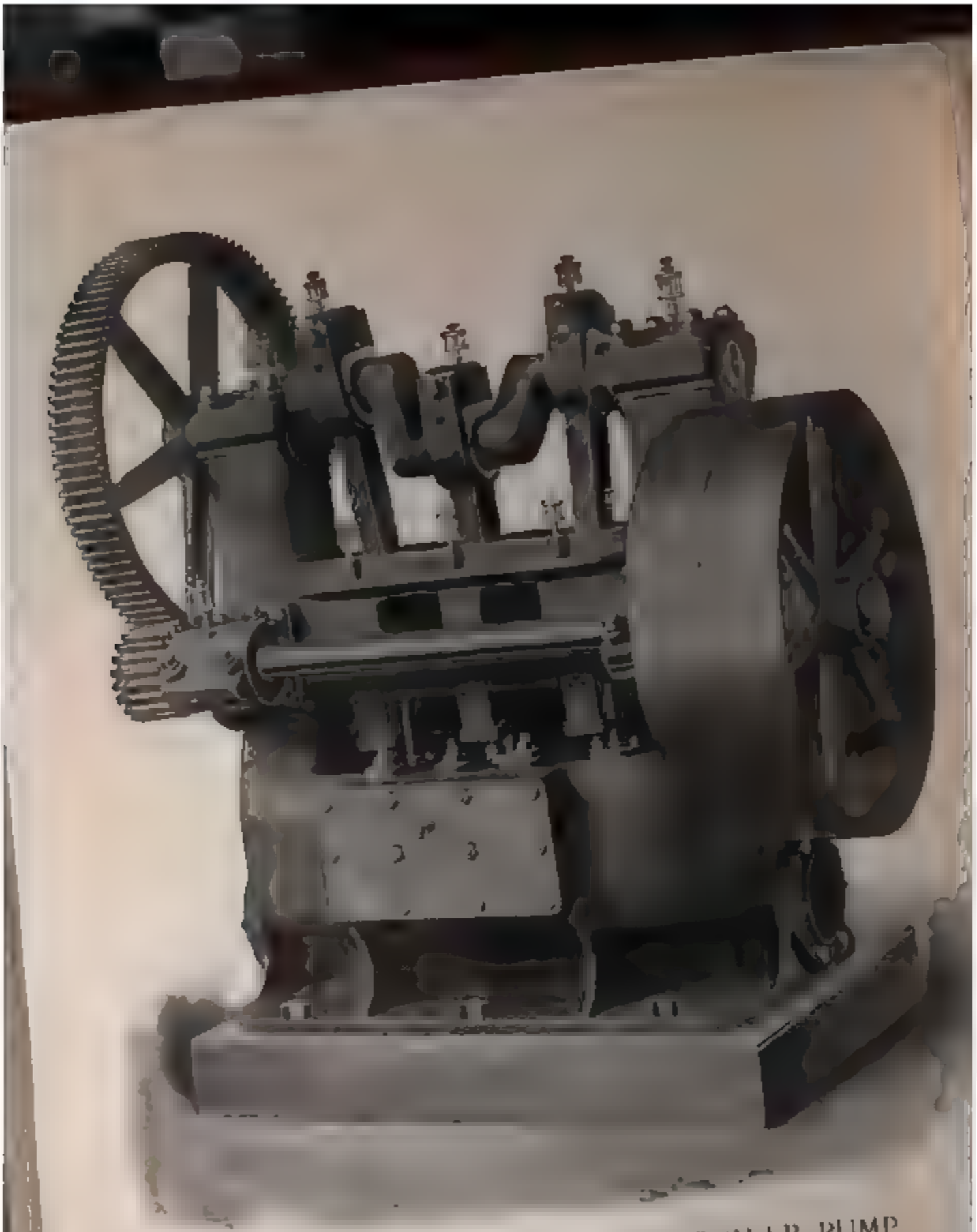


Triplex Electric Pumps (Geared)
100 ft. Lift. Style "E"



Triplex Electric Pumps (Close Belted).
100 ft. Lift. Style "E"

Diameter of Plungers.	Stroke.	Revs. per Min.	Gallons per Revolution	Gallons per Minute	Suction	Discharge	Pulleys Tight and Loose Diam.	Pulleys Tight and Loose Face	Ratio of Pump Gears	Ratio of Motor Gears	H. P. Motor Required	Dimensions Over All Belted Pumps Not Arranged for Motor A	B	C	Dimensions Over All Arranged for Motor Geared. A	B	C	Dimensions Over All Arranged for Motor. Close Belted A	B	C	Telegraphic Code Word: Belted Pumps Not Arranged for Motor.	Electric Pumps Geared. Arranged for Motor.	Electric Pumps. Close Belted. Arranged for Motor.
4	4	45	.54	24.48	2	2	20	3	5 to 1	To Suit Speed of Motor	1½	38¼	28½	34⅞	42½	29	51	42½	54½	34	Factive	Fading	Macaw
4	6	40	.81	32.63	2	2	20	3	4 to 1		2	38¼	28½	34⅞	42½	29	52	42½	54½	34	Factorage	Fagging	Macbeth
5	6	40	1.28	51.00	3	3	20	4	4 to 1		3	45¼	34½	43½	49½	41	61¼	49½	64	42	Factotum	Fagot	Maccabean
5	8	40	1.70	68.00	3	3	20	4	4 to 1		4	45¼	34½	43½	49½	41	67				Factual	Failing	
6½	8	40	2.77	114.93	4	4	26	5	4 to 1		7	49¼	39¼	51¼	54¼	45	74				Facture	Failure	
7	8	40	3.33	133.28	5	4	30	5	4¼ to 1		8	55	43	54	60	47	80				Faculty	Fainted	
8	8	40	4.35	174.07	5	4	30	6	5 to 1		10	56	48	59	62½	48	85				Facund	Fainting	
8	10	40	5.46	217.50	5	4	36	6	5 to 1		12½	58¼	48	68	65	48	94				Faddle	Faintly	
8	12	40	6.53	261.10	5	4	36	6	5 to 1		15	60	48	68	74	48	96				Fadeless	Faintness	
9	10	40	6.88	275.40	6	5	36	6	5 to 1		17	60	50	71	74	50	100				Fadengold	Fairhood	
9	12	40	8.26	330.40	6	5	42	8	5 to 1		20	80	50	75	85	53	106				Fadengrade	Fairings	
10	12	40	10.20	408.00	8	7	42	8	5 to 1		25	84	52	80	89	53	115				Fadenklee	Fairishly	



KNOWLES VERTICAL TRIPLEX POWER PUMP

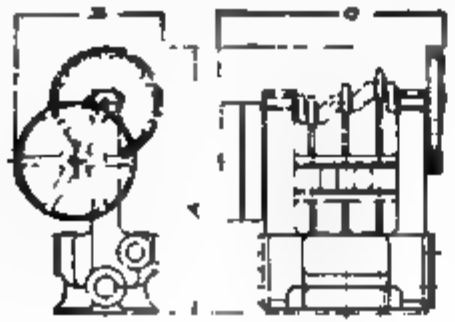
Style "L," Type No. 1.

Belted Pump. Double-Acting Piston Pattern.

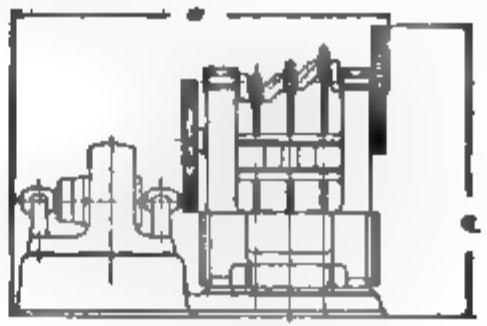
Knowles Vertical Triplex Pumps—Style "I," Type No. 1.

Double-Acting Piston Pattern.

IN construction this pump differs slightly from Style "I," Type No. 2, it having the valve chests and crosshead guides cast with the frame, the latter being also somewhat different style. Valve chests are located on front and back of pump and are furnished with large handhole plates, the removal of which gives access to valves. The crosshead guides being cast with the frame form a tie, thereby making the pump of exceptional strength and rigidity. The crank shaft is in one piece, working in babbitted bearings. All gears are cut, thus increasing smoothness of action and life of pump. Connecting rods are of steel having babbitted boxes, made in halves with key adjustment on crank end, crosshead end being solid with brass bushings. Belted pumps are furnished with tight and loose pulleys. Ample suction and discharge openings are located on either side. The hollow frame is utilized as a discharge air chamber. The removal of the upper pump cylinder head gives access to piston when adjustment is required. The extended bed-plate, for the electric type, is designed especially to receive the specified type and size of motor. A pinion of fibre will be furnished for the armature shaft, so as to reduce the noise to a minimum, if specially ordered, at extra price; otherwise a cast-iron cut pinion will be furnished. All material is of the highest grade, and great care is taken in the test to prove there is no defect. The sizes in upper table are suited for a pressure of 100 pounds, in lower table for a pressure of 130 pounds. In sending inquiries or orders, always state as fully as possible the intended service and requirements.



Triplex Power Pumps (Belt Driven).
Double-Acting Piston Pattern. Style "I," Type No. 1.



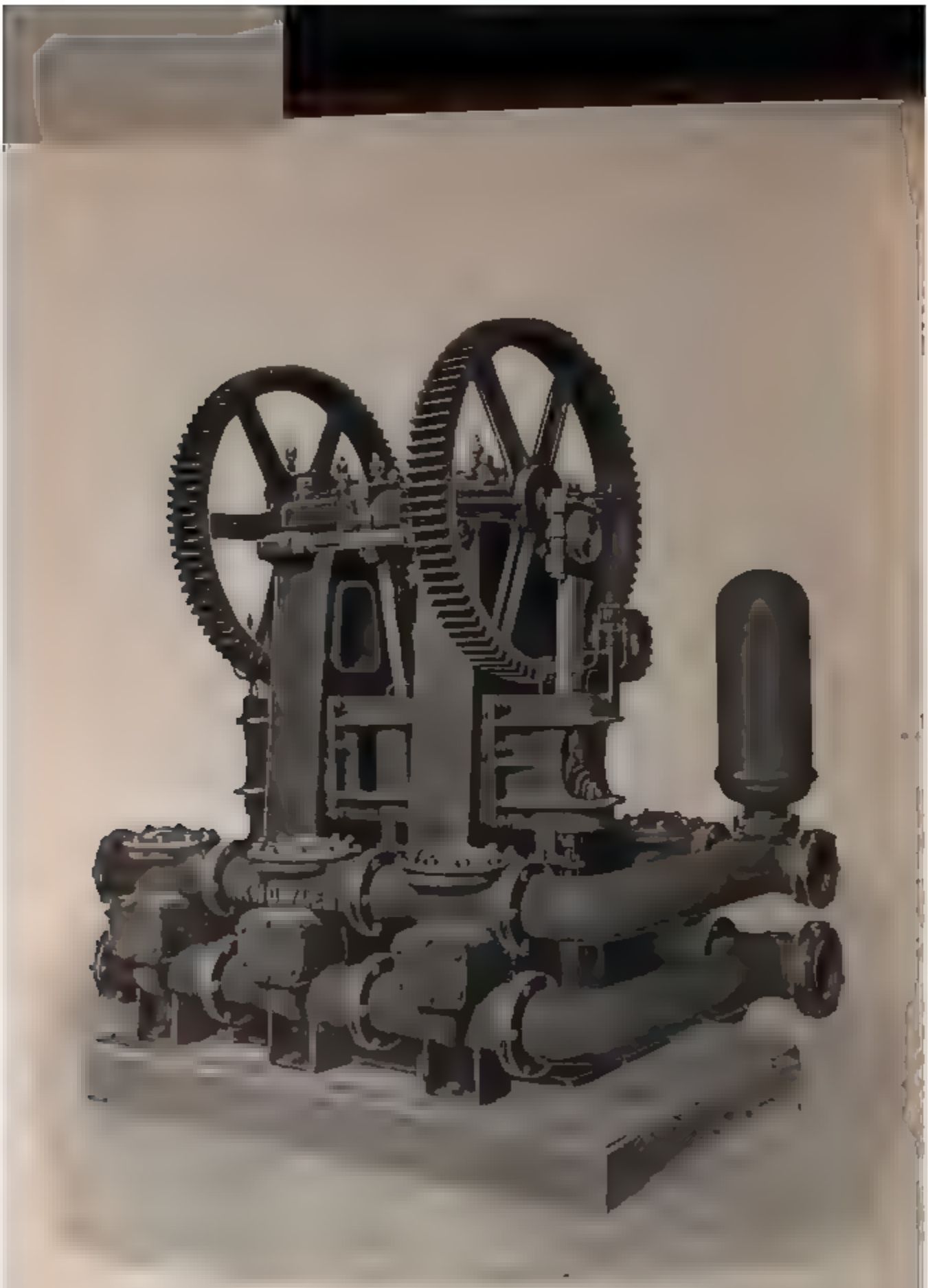
Triplex Electric Pumps (Geared).
Double-Acting Piston Pattern. Style "I," Type No. 1.

FOR 100 LBS. PRESSURE

Diameter of Pistons.	Stroke.	Revolutions per Minute.	Gallons per Revolution	Gallons per Minute	Suction.	Discharge.	Pulleys Tight and Loose: Diam.	Pulleys Tight and Loose: Face	Ratio of Pump Gears	Ratio of Motor Gears.	H. P. Motor Required.	Dimensions Over All Belted Pumps Not Arranged for Motor: A	B	C	Dimensions Over All, Arranged for Motor Geared: A	B	C	Telegraphic Code Word. Belted Pumps Not Arranged for Motor.	Electric Pumps, Geared, Arranged for Motor.
6	8	45	4.[illegible]	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	5 to 1	To Suit Specified Motor.	25	6' 3"	5' 8"	5' 0"	6' 10"	4' 8"	9' 10"	Mailath	Maillot
6½	8	45	5.21	2[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5 to 1		30	6' 3"	5' 11"	5' 0"	6' 10"	5' 0"	9' 10"	Mailaub	Mailloun
7	8	45	6.06	300	[illegible]	[illegible]	[illegible]	[illegible]	5 to 1		35	6' 3"	5' 11"	6' 0"	6' 10"	5' 0"	10' 4"	Mailich	Mailuft

SIZES BELOW ARE FOR 130 LBS. PRESSURE

6½	8	45	5.74	258	[illegible]	[illegible]	32	[illegible]	5 to 1	To Suit Specified Motor	40	6' 5"	4' 6"	6' 0"	7' 0"	5' 6"	10' 4"	Mainata	Maintained
7	8	45	6.66	300	[illegible]	[illegible]	37	[illegible]	5 to 1		45	6' 5"	4' 8"	6' 4"	7' 0"	5' 8"	10' 6"	Mainbour	Maintenant
8½	10	45	7.15	323	[illegible]	[illegible]	45	[illegible]	5 to 1		50	7' 1"	5' 0"	6' 4"	7' 8"	6' 0"	10' 6"	Mainmorte	Mainteniez
9½	10	45	8.33	375	[illegible]	[illegible]	54	[illegible]	5 to 1		55	7' 1"	5' 3"	6' 4"	7' 8"	6' 3"	10' 8"	Mainote	Maintenous
7																			



KNOWLES VERTICAL TRIPLEX POWER PUMP.

STYLE "I," Type No. 2.

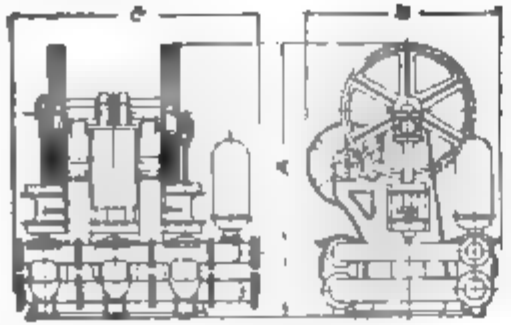
Double-Acting Piston Pattern.

Knowles Vertical Triplex Pumps—Style "I," Type No. 2.

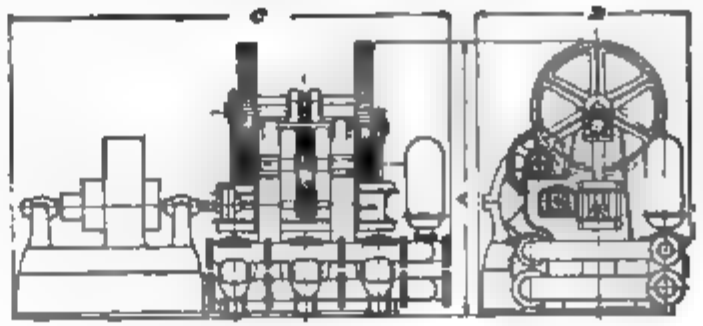
Double-Acting Piston Pattern.

THE construction of this pump differs somewhat from the plunger pattern, Styles A, F, and H, it having three double-acting pistons and the marine pattern connecting rod. The crank shaft is in one piece, working in babbitted bearings, supported between centre and outside cranks. The crossheads being guided, sustain the side thrust of the connecting rods. The power is transmitted direct to the pistons in the manner spoken of in description of Styles A and F. Connecting rods are steel, having babbitted boxes with adjustment on both ends. Each pump is furnished with a tight pulley and discharge air chamber, and has ample suction and discharge openings on either side. The removal of plates on top and side of valve chambers gives access to each set of suction and discharge valves. Upper pump cylinder heads, being made in halves, are easily removed, giving access to piston when adjustment is required. All gears are cut. The extended bed-plate, for the electric type, is designed especially to receive the specified type and size of motor. A pinion of fibre will be furnished for the armature shaft, so as to reduce the noise to a minimum, if specially ordered, at extra price; otherwise a cast-iron cut pinion will be furnished. All material is of the highest grade, and great care is taken in the test to prove there is no defect. The sizes in the following table are suited for a pressure of 150 pounds.

In sending inquiries or orders, always state the water pressure.



Triplex Power Pumps (Belt Driven).
300 ft. Lift. Double-Acting Piston Pattern. Style "I" Type No. 2



Triplex Electric Pumps (Geared).
300 ft. Lift. Double-Acting Piston Pattern. Style "I," Type No. 2

Diameter of Pistons.	Stroke.	Revolutions per Minute.	Gallons per Revolution.	Gallons per Minute.	Suction.	Discharge.	Pulley — Diam.	Pulley — Face.	Ratio of Pump Gears.	Ratio of Motor Gears.	H. P. Motor Required.	Dimensions Over All, Belted Pumps Not Arranged for Motor. A	B	C	Dimensions Over All, Arranged for Motor, Geared. A	B	C	Telegraphic Code Word. Belted Pumps Not Arranged for Motor.	Electric Pumps Geared. Arranged for Motor.
7	12	40	12.09	480	8	6	20	16½	5 to 1	To Suit Speed of Motor	50	114	70	88	101	85	150	Fancied	Fance
8	12	40	15.65	626	8	6	26	16½	4 7/8 to 1		65	121	70	89	101	88	155	Fanciful	Farcical
9	12	40	19.63	785	10	8	32	16½	5 to 1		80	131	74	89	101	92	162	Fancy	Farewell
10	12	40	24.48	979	12	10	42	18½	6 to 1		100	136½	84	96	116½	104	175	Fandango	Farina
11	12	40	29.62	1185	12	10	52	20½	6 to 1		120	143	86½	105	123	108	188	Fanged	Farmer
12	12	40	35.25	1410	14	12	50	24½	6 to 1		150	152	90	115	132	116	200	Fangless	Farming

KNOWLES VERTICAL TRIPLEX POWER PUMP.

Style "K." Belted Pump. Double-Acting Piston Pattern.

SIZE 12x12.

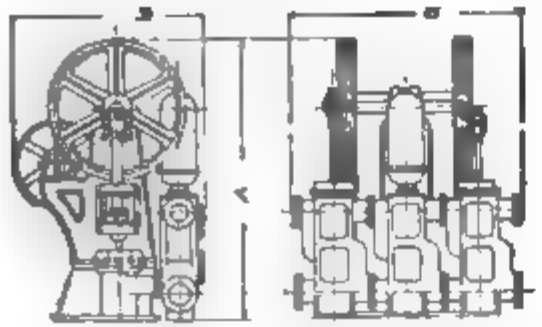
Pumps of smaller sizes have Valve Chests of different construction.

Knowles Vertical Triplex Pumps—Style "K."

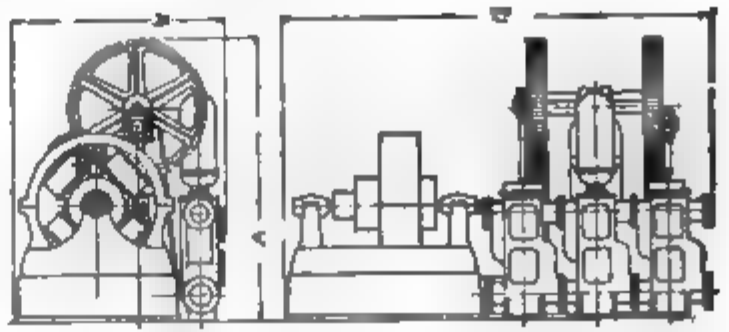
Double-Acting Piston Pattern.

THIS line of power pumps is designed for light service, where delivery of a large volume is required at a low pressure, and where floor space is restricted. The crank shaft is in one piece, working in adjustable babbitted bearings, liberally proportioned. The power is transmitted direct to the pistons in the manner spoken of in description of Styles A and F. The connecting rods are steel, marine pattern, having adjustable babbitted boxes on both ends. There are ample suction and discharge openings on either side, and each pump is furnished with a tight pulley and discharge air chamber. Access to all valves is made easy by the removal of ample handhole plates on the valve chambers.

The adjustment of pistons is readily accomplished by the removal of the upper pump cylinder heads, which are made in halves for this purpose. All gears are cut. The extended bed-plate, for the electric type, is designed especially to receive the specified type and size of motor. For the armature shaft we will furnish a fibre pinion, to reduce the noise to a minimum, if specially ordered, at extra price, otherwise a cast-iron cut pinion will be furnished. The highest grade of material is used, and great care is taken in the test of pump to prove there is no defect. The following sizes are suitable for a pressure of 50 pounds. In sending inquiries or orders, always state the water pressure.

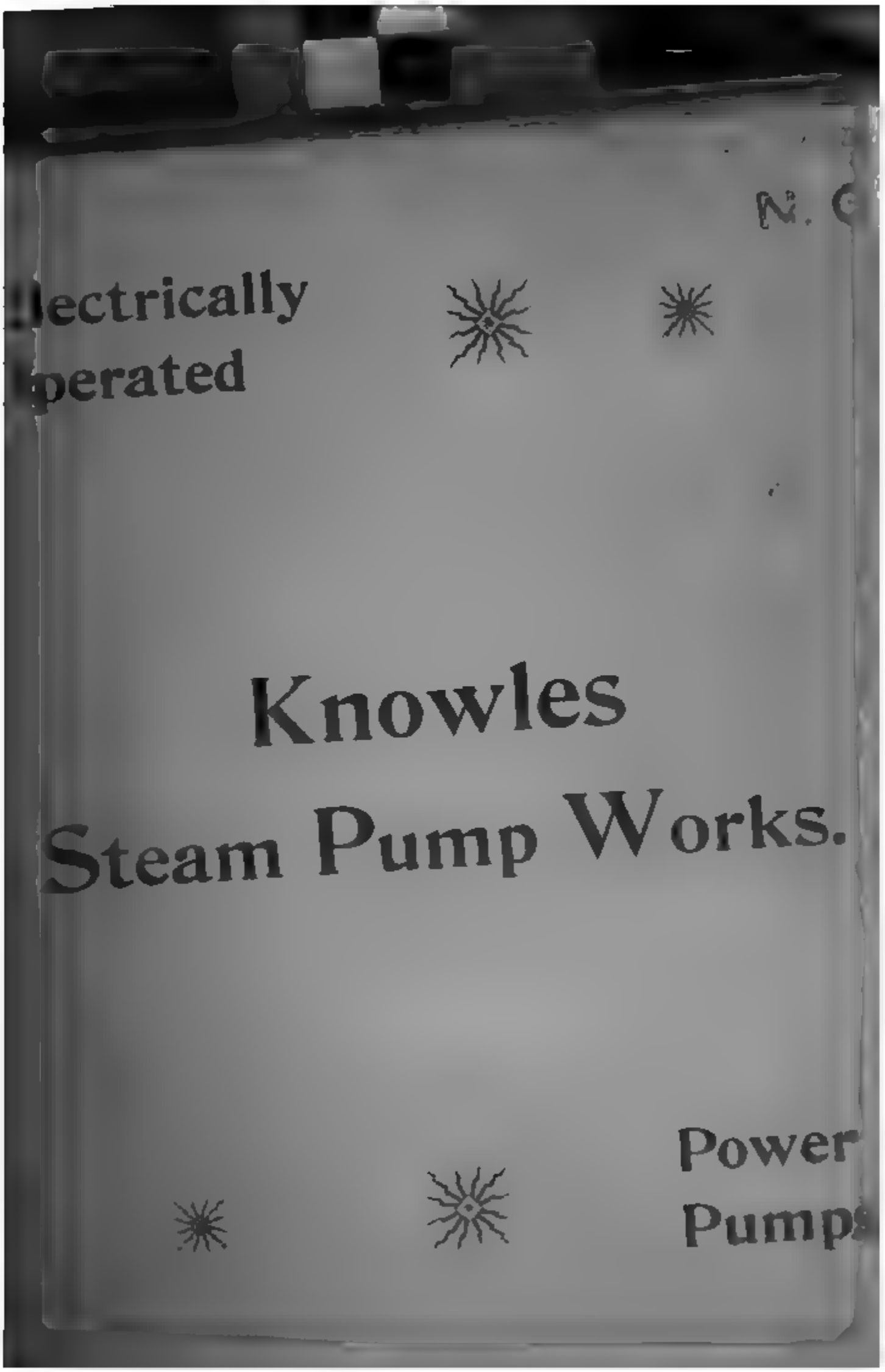


Triplex Power Pumps (Belt Driven
100 ft. Lift. Double-Acting Piston Pattern. Style "K."



Triplex Electric Pumps (Geared).
100 ft. Lift. Double-Acting Piston Pattern. Style "K."

Diameter of Pistons.	Stroke.	Revolutions per Minute.	Gallons per Revolution.	Gallons per Minute.	Pulleys: Suction	Pulleys: Discharge	Pulleys: Diam.	Pulleys: Face	Ratio of Pump Gears.	Ratio of Motor Gears.	H P Motor Required.	Dimensions Over All Belted Pumps Not Arranged for Motor. A	B	C	Dimensions Over All, Arranged for Motor, Geared. A	B	C	Telegraphic Code Word. Belted Pumps Not Arranged for Motor.	Electric Pumps, Geared Arranged for Motor.
10	10	40	13.05	522	8	6	8	12½	5 to 1	To Suit Speed of Motor.	25	96	63	82	98	29	130	Maccum	Macellando
10	10	40	16.52	661	8	6	8	12½	5 to 1		30	96	74	86	98	51	150	Macenban	Macellassi
12	10	40	19.83	793	10	8	8	14½	5 to 1		35	101	76	80	101	88	155	Macenadores	Macellava
12	12	40	24.45	978	12	10	8	14½	5 to 1		40	116½	79	83	116½	91	168	Maceados	Macellinus
12	12	40	29.62	1185	12	10	8	14½	5 to 1		50	121	79	96	121	103	180	Maceare	Macellorum
12	12	40	35.25	1410	14	12	8	14½	5 to 1		60	132	87	106	132	110	192	Maceasemos	Macerubat
12	12	40	41.34	1654	14	12	8	16½	5 to 1		70	140	96	115	140	115	205	Maceasteis	Macerador
12	12	40	47.04	1918	16	14	8	16½	5 to 1		80	148	98	125	148	130	220	Macebat	Macerun


lectrically
perated
Knowles
Steam Pump Works.
Power
Pumps

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SPECIAL CATALOGUE

—OF—

ELECTRIC

POWER PUMPS,

MANUFACTURED BY THE

KNOWLES STEAM PUMP WORKS,

93 LIBERTY STREET,

NEW YORK.

BOSTON:
183 DEVONSHIRE ST.

LONDON:
117 QUEEN VICTORIA ST.

CHICAGO:
163 SO. CANAL ST.

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KNOWLES STEAM PUMP WORKS.

UNLIKE many machinery catalogues, the one presented herewith is compiled, not from designs and data of types as yet largely on the draughting board, and with the hope of influencing business by sheer force of novelty and ingenuity, but from knowledge of apparatus already built in our own shops, and thoroughly proven in actual service by customers throughout the world. We fully realize its lack of completeness—the rapid advance in electrical engineering methods compels a corresponding activity in producing auxiliary apparatus—but have tried to select such types as would probably meet the needs of the largest classes of our customers, omitting intentionally many designs not really obsolete, but adapted less for general than for special uses, and of necessity many patterns not yet standardized or sufficiently tested under working conditions.

In fact we have intended in preparing this catalogue to make it largely suggestive, rather than authoritative, in character, knowing that satisfactory relations between manufacturer and customer can only be brought about by a thorough understanding of the considerations involved in every case submitted, and hearty co-operation in securing the best possible results.

We are always pleased to confer with our patrons concerning pumping problems of every variety, and to render them every service in our power in obtaining the apparatus best suited to their requirements.

General Considerations.

While the fact that we manufacture *every variety* of pumping machinery, whether for operation by steam, air, hydraulic, electric or any other power, is, in itself, sufficient to show that our position is unprejudiced, there are certain elementary truths in favor of electrical as compared with other methods of operation, which must always have great weight unless counterbalanced by economical considerations due to special circumstances.

It is rare that the one feature of *economy* is made secondary to others, either of an æsthetic or personal nature, in purchasing apparatus of any kind, and as a rule the machine or system producing the greatest amount of *effective work* from a given amount of primary energy, will receive the most favorable consideration.

Starting therefore from the coal pile, it is a well known and easily proven fact that a direct acting steam pump of the ordinary commercial type will require a greater coal consumption for a given service than a power pump of similar capacity, electrically operated, and in spite of the intermediate efficiency losses in engine, generator and motor.

Another point often of weight in influencing a final decision is the compactness and flexibility of the connecting elements between the pump and its source of power supply. Properly insulated wires may be located in cramped spaces, or imbedded in walls, without providing facilities for inspection, when steam pipes would be entirely out of the question. The cost of maintenance and repairs on this part of an electric installation is also an item which counts heavily in favor of electric power.

Architects

find in electric pumps the means for providing public and private buildings with elevator service,

refrigeration, fire protection, etc., etc., to a degree otherwise impossible without the constant employment of skilled engineers and assistants. By the use of roof or pressure tanks and proper automatic appliances for controlling the pumps, systems of this character may be maintained in constant readiness for occasional or protracted use, obtaining their current from the street lighting or power mains, with only such attention as any reasonably intelligent elevator boy or janitor is capable of giving, and without the jar and vibration inseparable from apparatus of a less refined type.

For Water Works service in towns and small cities, the use of electric power is in many cases the most economical solution of the pure water supply problem which often means the growth or abandonment of a neighborhood.

The same steam plant which lights their streets and homes at night, whether under direct municipal control or not, may be utilized by the citizens of enterprising communities for filling reservoirs during the day, thus getting a practically continuous service from the equipment, instead of having two seperate outfits, each with its corps of attendants, and lying idle half the time. A water power is often available, the energy of which may be transmitted by electrical means to the pumping plant miles away, thus eliminating entirely the element of fuel cost, and reducing expense to the simple items of interest and maintenance.

In Manufacturing Processes the electric pump is rapidly proving its valuable qualities for maintaining a constant pressure or output under varying conditions, or for providing an instantly available means of protection or special supply in case of emergency, either with or without *automatic* control.

One of the not least valuable features of electrical operatio

under these circumstances, is the fact that a motor consumes current almost exactly in proportion to the load—in other words, though the speed may remain the same, the consumption of current (save enough to overcome the friction of its two bearings) ceases immediately upon the removal of the load, or in proportion as it is removed.

For All Purposes the electric power pump appeals alike to the engineer, the purchaser and the operator by its simplicity, compactness, freedom from complicated or concealed mechanism, and general smoothness of operation.

It has been our policy to confine our attention strictly to the building of pumping apparatus, without taking up the manufacture of electrical devices of any kind, or favoring those of one make more than another.

We are therefore in a position to supply our machinery in connection with any type of motor, keeping constantly in touch with the foremost manufacturers for this purpose, and having on file all information necessary for combining the electric and hydraulic portions of the apparatus in the most compact, efficient and economical manner, and with special reference to the service intended.

Our Guarantee. Each and every pump built and sold by us is fully guaranteed; in case of the failure of any of our machines to properly perform the service for which they are warranted, we hold ourselves under obligation to make the same fully satisfactory, or to refund the amount paid.

KNOWLES STEAM PUMP WORKS.

Triplex Belted Power Pumps.

THE great advantage of the triplex form of power pumps over the single or duplex type is fully recognized by the best engineers for all cases in which a steady and continuous discharge is desired, either for producing an even hydraulic pressure, or for preventing water-hammer and unpleasant vibration for elevator or other service in which entire absence of noise is desirable. Even where the adoption of this type is not a necessity for these reasons, its easy running qualities and entire absence of "pound" or jar or piping and foundations recommended its adoption in the majority of cases where final economy is considered, rather than cheapness in first cost.

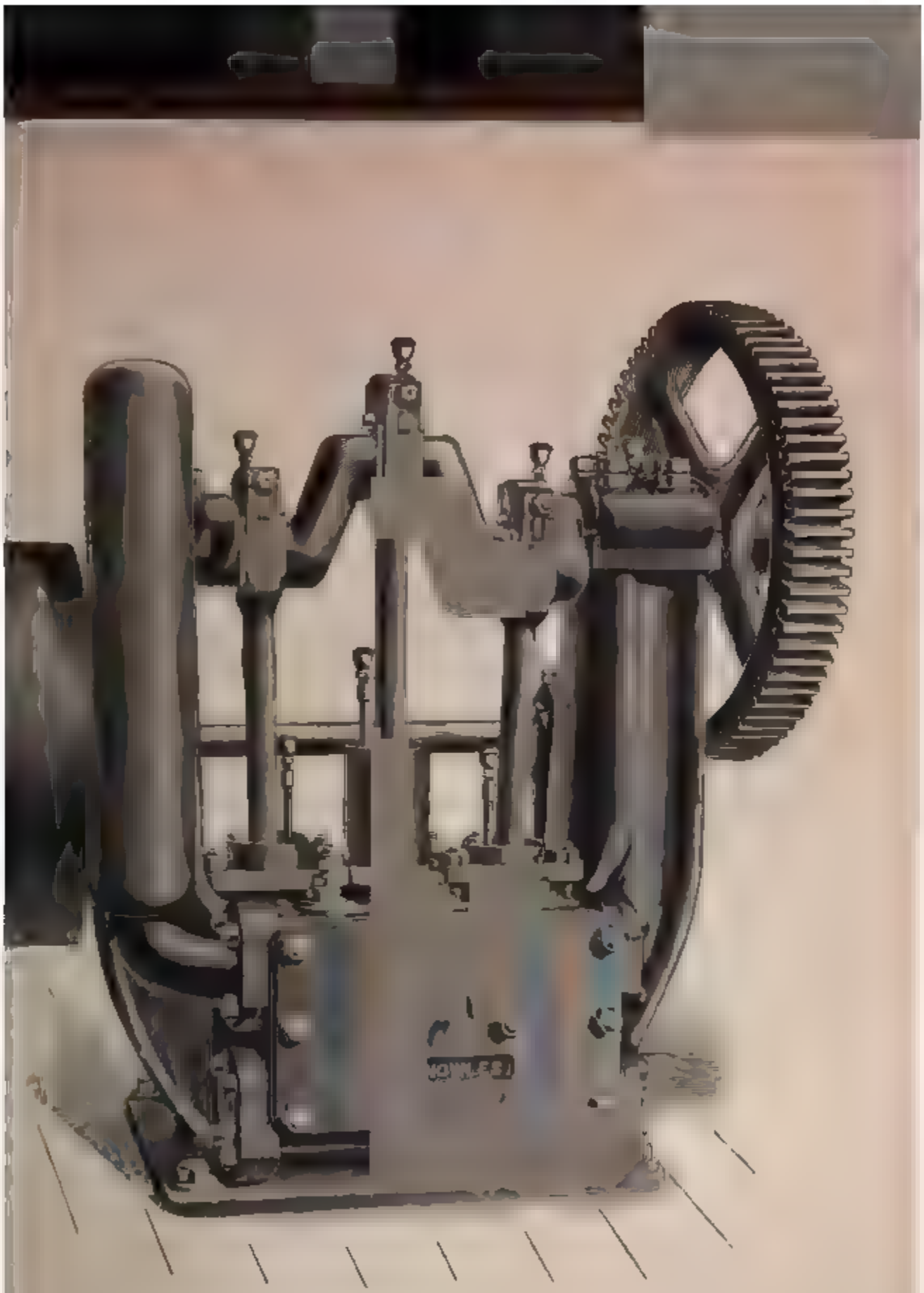
Excepting in the three smallest sizes, these pumps (see pages 9 and 10), are arranged so that either the suction or discharge, or both, may be located on either side of the apparatus, often a point of considerable advantage in crowded locations. While every part is designed to secure the utmost compactness, the valve chambers are arranged so as to allow easy access for inspection or repair. All gears are cut and shaft boxes babbited. Connecting rods have adjustable brass boxes secured by keys, and the lower ends of connecting rods are held in the plungers by steel pins working in brass bushings in the solid ends of the rods. For direct motor connection these pumps are fitted with an extended base plate, and the tight and loose pulleys replaced by gearing, as shown on page 13.

☞ We issue a special catalogue of power pumps adapted for use in Paper and Pulp Mills, Chemical Works and manufacturing processes generally. Mailed to any address on application.

Diam. of Cylinders.	Stroke	Suction.	Discharge.	Gallons per revolution.	Revolutions per min	Gallons per minute	Tight and loose pulleys.	Ratio of gearing.	Weight complete.	Style of rearing.	Over all. Height.	Width	Depth	Price.	Code word.
1¼	2	¾	¾	.0319	60	1 914	12x2¼	5 to 1	164	B	19¼	16¼	12⅝		Dabble.
1½	2¼	1	1	0732	60	4.392	12x2½	"	373	"	27	23¼	15¼		Dabster.
2	3	1¼	1¼	.1224	50	6 120	12x2¼	"	370	"	27	23¼	15¼		Dado.
2¼	4	1½	1½	.2550	50	12.75	15x3	"	400	"	29	31¼	23		Dagger.
3	4	1½	1½	.3673	45	16 53	15x3	"	675	"	29	31¼	23		Dainty.
4	4	2	1½	.6528	45	29 37	20x3	"	738	"	39¼	38¼	28¼		Dairy.
4	6	2	2	.9787	40	39 15	20x3	"	1,228	"	39¼	38¼	28¼		Dahlia.
5	6	3	3	1.530	40	61.20	26x4	"	1,680	"	48¼	46¼	34¼		Dally.
5	8	3	3	2.040	40	81.60	30x5	"	1,840	"	48¼	48¼	36¼		Damask.
6¼	8	4	4	3 448	40	137.92	30x6	"	3,648	"	59	62¼	42¼		Damper.
8	8	5	4	5.222	40	208 88	36x6	"	5,500	"	62	70¾	49¼		Damsel
8	10	5	4	6 520	40	260.8	40x6	"	6,800	"	65	74¼	51¼		Dander.
8	12	5	4	7.833	40	313.32	42x6	6 to 1	13,000	A	8 9	7 3⅝	6 9		Dapper.
9	10	6	5	8.262	40	330 48	42x6	"	13,000	"	8 2	7 5	6 9		Darkly
9	12	6	5	9.915	40	396.60	42x6	"	13,000	"	8 10	7 5	6 9		Darling
10	12	8	7	12.243*	40	489 72	*42x8	"	15,000	"	8 10¼	7 7⅛	6 9		Dastard.
11	12	8	7	14 811	40	592.44	*42x8	"	16,000	"	8 10¼	7 10¼	6 9		Dauber.
12	12	10	8	17.628	40	705.12	*48x8	"	18,000	"	9' 1"	8' 10"	7 2		Daunted
13	12	10	8	20.685	40	827.40	*48x10	"	20,000	"	9' 1"	9 1	7 2		Dazzle.

* Belt should be double.

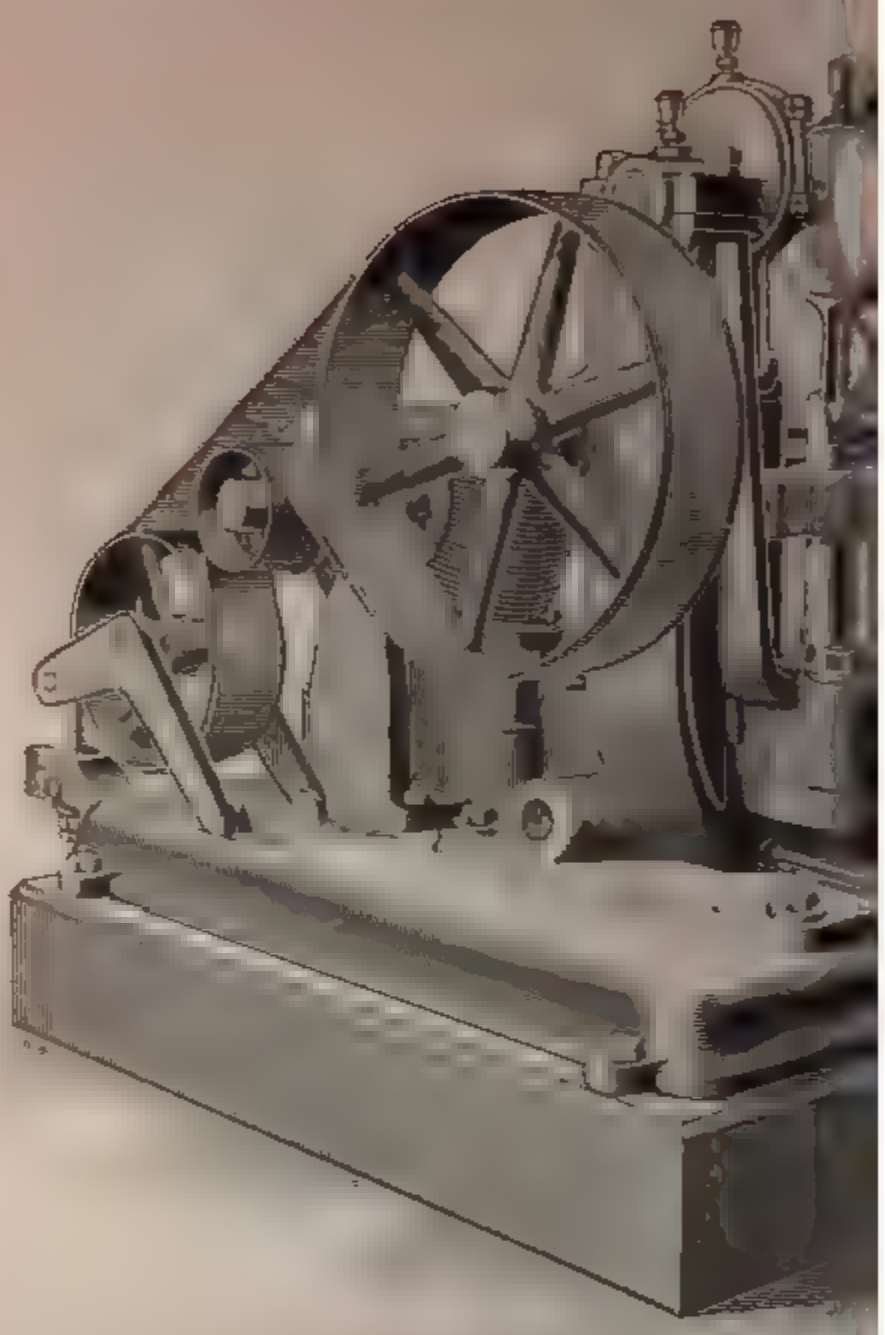
Note. First three sizes have one discharge opening the fronts and suction on each side. All other sizes have both suction and discharge openings on each side. For pressures above 125 pounds per square inch see page 19.



Vertical Triplex Belted Power Pump.

Size 4x6 Style B

For description see page 7



Special Belt Driven Vertical T
Power Pump.

THIS illustration shows one of the smalle
pumps with extended bed-plate for electri
special form of belt transmission instea
nary pattern.

While not mechanically so efficient a devic
gears, this arrangement combines the noiselessn
with extreme compactness, making it a very
hotel and public building service.

Vertical Triplex Geared Pumps.

ACKNOWLEDGED the best type for general power purposes, we confidently claim the pump illustrated on pages 13 and 15 to be at the head of this class in excellence of materials and workmanship.

The general design is strong and compact and the arrangement of parts is the best to facilitate inspection. The merits of the TRIPLEX OR THREE-THROW PATTERN are recognized by all that have used the pumps, because the cranks are set at angles that will bring the plungers continuously upon the water-column without any shock from reversing the stroke; by this means the pumps discharge uniformly and without pulsation.

The gears are cut and run noiselessly, and shafts work in babbited boxes, hammered and bored-out to an exact fit. The plungers are packed from outside so any leakage may be readily detected. The connecting rods are made with adjustable composition metal boxes and keys; the lower ends of rods fitted with composition metal bushings and held in the plungers by steel pins. Both suction and discharge valves can be examined by removing one cover.

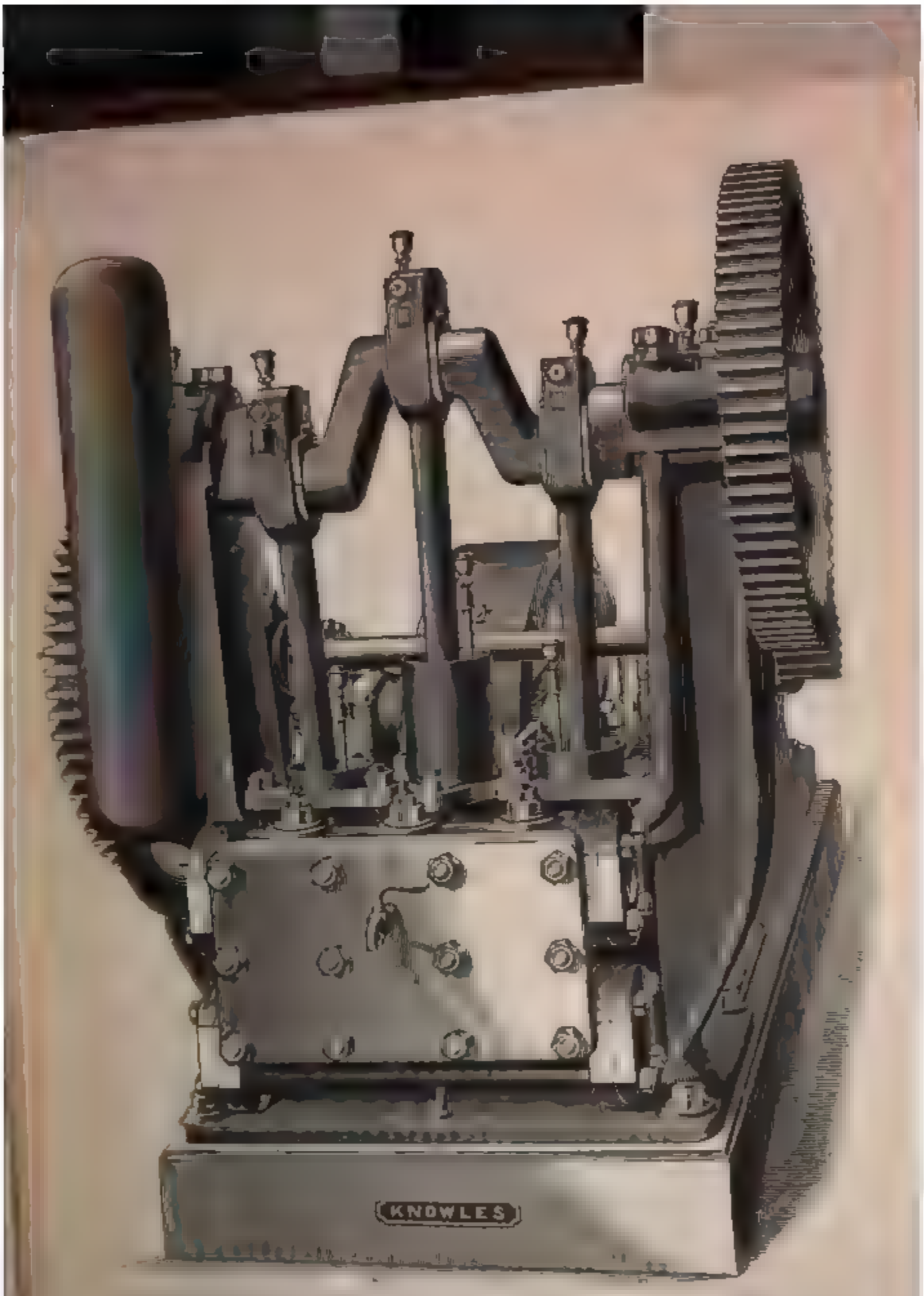
Each pump is provided with discharge air chamber and has suction and discharge openings on either side. All material is of the highest grade, and the utmost care is taken in testing to discover defects.

The extended bed plate is designed especially to receive the specified type and size of motor, and a rawhide pinion is provided for the armature shaft so as to reduce noise of operation to a minimum.

☛ See note on page 7.

Diam. of Cylinders.	Stroke	Suction.	Discharge	Style of Gearing.	Ratio of Gearing.	Gallons per Rev	Rev. per Minute	Gal. per Minute	Weight Ready for Motor	Size Motor (H.P.) for 100-125 lbs. Pressure.	Weight Complete.	Over all. Height.	Width.	Depth	Price.	Code word
1¼	2½	¾	¾	B	35	0319	50	1 6	150	¼	195	19½	12	18		Deadly.
1½	2½	1	1	"	30	0732	50	3.7	382	½	460	29½	19½	24½		Deacon.
2	3	1¼	1¼	"	30	1224	45	5.5	393	¾	540	29½	19½	24½		Debate.
2½	3½	1½	1½	"	25	2550	45	11 5	465	1	775	29	28½	24½		Decade.
3	4	1½	1½	"	25	3673	40	14.7	788	1½	1110	29	28½	36		Decamp.
4	4	2	2	"	25	6528	40	26	873	2	1310	32½	34	41		Decay.
4	5	2	2	"	25	9787	40	40	1731	3	2480	43½	34½	47½		Deceit.
5	6	3	3	"	20	1.530	"	61	2272	4	3275	52½	40½	51½		Decease.
5	8	3	3	"	20	2 040	"	82	2497	5	4175	51	40½	58		Decoy
6½	8	4	4	"	18	3 448	"	138	4626	7	8675	59	53½	66½		Decree.
8	8	5	4	"	16	5.222	"	210	6324	10	8960	62	61½	76½		Deduce.
8	8	5	4	"	15	6 520	"	261	7553	15	10650	65	66	80		Deface.
8	10	5	4	A	15	7 833	"	314	13271	20	17200	8 2	7 2	8 8'		Defeat.
9	12	5	4	"	14	8.262	"	330	14200	25	18700	8 2'	7 5	9 3		Define.
9	10	6	5	"	14	9,915	"	400	16650	30	22050	8 6	7 5"	9' 4"		Deform.
9	12	6	5	"	14	12 243	"	490	17850	35	23250	8 10½	7 7	9 10½		Defraud.
10	12	8	7	"	14	14 811	"	592	19150	40	23050	8 10½	7 10"	9 10½		Deject
11	12	8	7	"	13	17 628	"	705	21200	50	27475	9 1'	8 10	10 5'		Deluge
12	12	10	8	"	12½	20 685	"	827	24000	60	30275	9' 1'	9 3	10 5'		Deport.
13	12	10	8	"	12½					75						

Above pumps have suction and discharge openings on each side except three smallest sizes—these have discharge opening in front and suction on each side. For pressures above 125 pounds per square inch see page 10



Vertical Triplex Electric Power Pump.

With Double Acting Outside Packed Plungers. Style B For description see page 11.

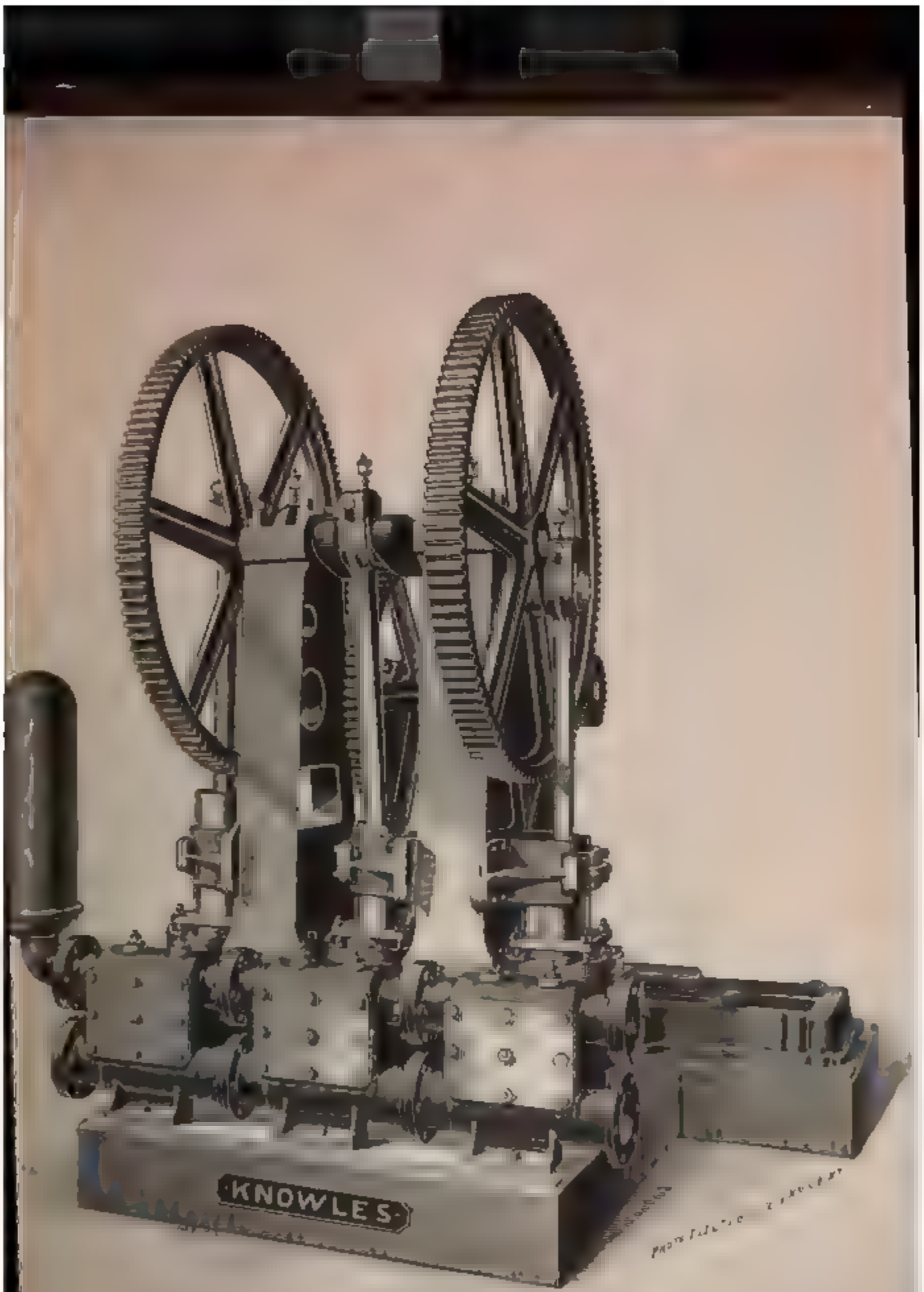
Vertical Triplex Pumps—Style A.

THE cut on the opposite page shows one of the larger sizes of vertical triplex electric power pumps, as it appears with extended bed plate ready for mounting the motor. In addition to its suitability for boiler feed, hydraulic and general tank service, this pump is especially adapted for mining operations, as it is designed so as to be easily taken apart, and readily put together again when necessary. It may also be built with phosphor bronze bushed cylinders, glands and solid plungers of same material to resist the action of sulphuric acid which is frequently encountered in mine pumping.

In common with the ordinary type of triplex pumps, having single acting cylinders and outside packed plungers, this design has the following exclusive features: The plungers are outside packed, guided above, relieving them of excessive wear or strain, and have brass bushed forged steel connecting rods of the locomotive type, with an adjustment at either end for wear. The power is transmitted direct to each of these plungers in the following manner: A countershaft behind the pump for connecting it with electric motor, transmits the power to spur gears at either end of the pump, driving by crank pins and face plates the two outside plungers, and at the same time through the single throw supporting crank shaft the centre or middle plunger.

The suction and discharge valves are all grooped in valve chambers and accessible through hand hole plates.

General data concerning these pumps will be found on page 12.



Vertical Triplex Electric Power Pump.

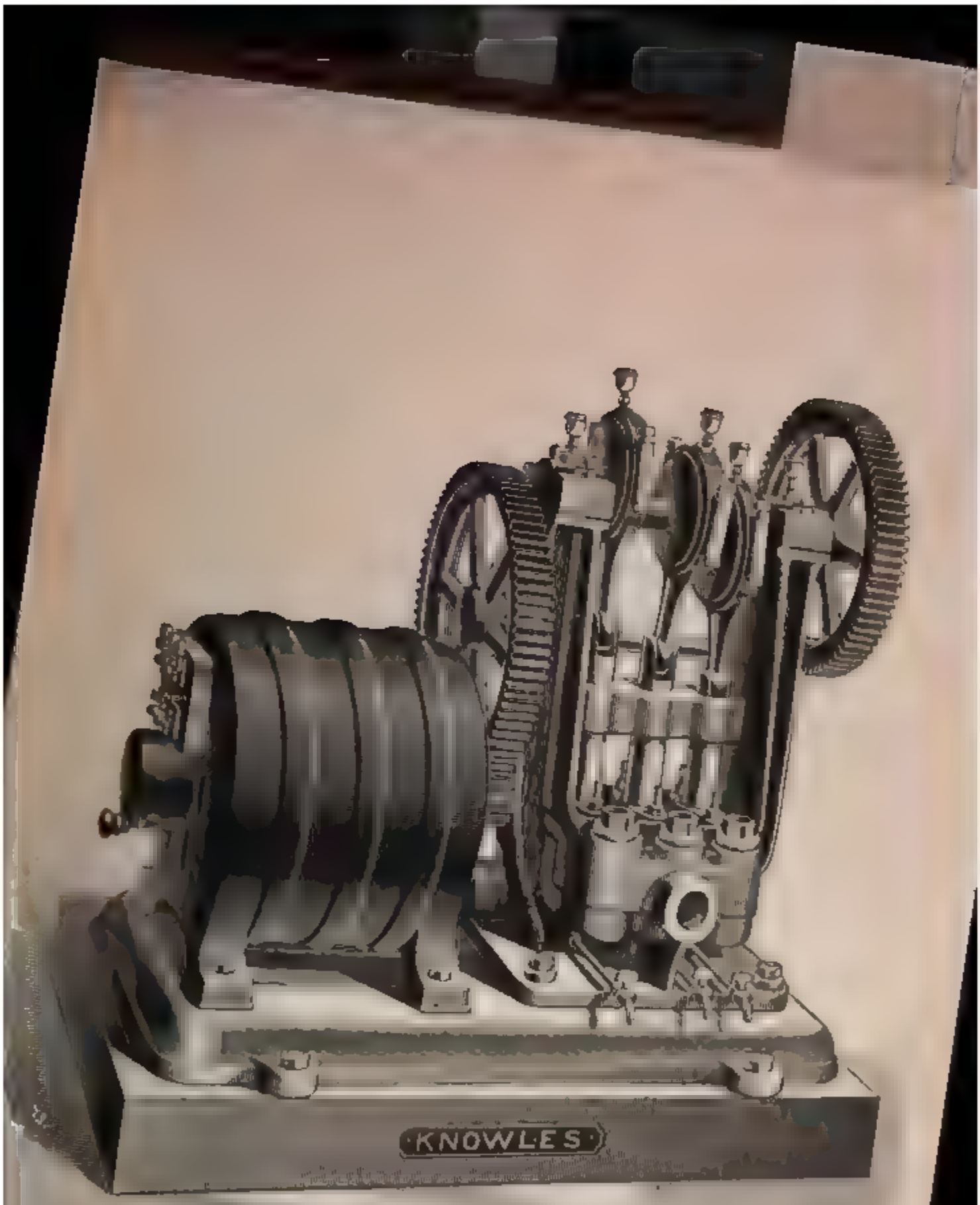
Size 8x12. Style A.

Showing Extended Bed-plate for receiving Motor

Alternating Current Electric Power Pumps.

THE rapid increase in the adoption of alternating current systems for general power and lighting service would render any catalogue of this character incomplete without a definite mention regarding this class of apparatus as applied to pumping work. We are prepared to submit designs and estimates of any type of pumps in connection with one, two or three phase motors to run on currents of any standard number of alternations, but at the time of going to press the lack of uniformity in this class of machinery as produced by different makers, both in speed and in general characteristics, as well as the possible influence of anticipated legislation, renders it inadvisable, even if it were possible, to present intelligent and at the same time comprehensive data within the limits of an ordinary reference table. The cut shows a 1¾x2½ Standard Vertical Triplex Pump, with single acting outside packed plungers, geared with a three phase alternating motor of 2 H. P. capacity. The entire absence of commutator and brushes in synchronous motors of this type renders their use especially advantageous in cases not requiring the motor to start under load.

We are prepared to estimate on *long distance pumping plants* of any desired magnitude, by the multiphase electric system, either for public or private service, and with or without general lighting and power distribution from the same wires. Owners of unused water powers in the vicinity of centres of population or large manufacturing interests may find it of advantage to correspond with us on this subject.



Vertical Triplex Electric Power Pump.

With Alternating Motor.

High Pressure Vertical Triplex Pumps.

AS THE pumps described in the preceding pages are designed for a maximum working head of about 300 feet (or equivalent service), a heavier and stronger pattern is often required for high pressure boiler feed, hydraulic presses and cranes, filter presses, cotton presses, oil mills, pipe works, deep mining, etc., and we have accordingly prepared the table given on the opposite page, showing a wide range of capacities for maximum pressures ranging from 300 to 5,000 pounds per square inch. The type of construction is in general the same as described on pages 7 9, with such modifications in dimensions and fittings as are called for by the service intended.

On apparatus of this character we prefer to make separate estimates for individual cases, in order to obtain the best results, and the table is therefore principally valuable as indicating by comparison the general dimensions and characteristics of machines suited to various classes of work. The peculiar smoothness of operation of *Triplex Pumps* especially recommends them for high pressure service, and our experience in every line of pump construction enables us to supply the necessary details of design and equipment promptly and to the best possible advantage.

Special Triplex Pumps.

WE BUILD a complete line of Triplex Air Compressors and Vacuum Pumps, also Suction Pumps for every variety of service. They are also furnished with special valves and fittings for pumping *Ammonia*, *Brine*, *Beer*, *Tan Liquor*, *Soap*, *Tar*, *Sewage*, *Chemicals in Solution*; in fact anything of a liquid or semi-liquid character.

Diam. of Cylinders.	Stroke.	Suction	Discharge.	Gallons per Revolution.	Rev. per minute	Gallons per minute.	Maximum Pressure lbs. per sq in	Tight and Loose Pulleys.	Ratio of Gearing.	Weight—lbs.	Over all. Inches.			Code Word.
											Height.	Width.	Depth.	Price.
1 1½ 2	4	1¼ 1½ 1½	1 1¼ 1½	.04 .09 .20	50 50 50	2.4 4.5 10.3	1500 1000 450	15x3 15x3 20x3	5 to 1	2400 2100 1700	28 28 30	30 30 32	18 18 23	Derange Deride Derrick
2 2½ 3	6 6 6	1 1½ 2	1¼ 1½ 2	.03 .14 .24	50 50 50	1.7 6.9 12.0	5000 1000 1500	20x4 30x6 30x6	7 to 1 5 to 1	3000 2400 3400	38 40 40	35 37 41	33 35 37	Descent Desert Deserve
3½ 4	6 6	2 2	2 2	.04 .98	40 40	15.5 39.1	300 300	30x5 30x5		3000 3400	40 41	39 43	36 39	Desist Despair
4 5 6½	8 8 8	3 3 3	3 4 4	.25 .41 .73	50 50 50	10.0 20.5 36.7	5000 1500 1500	36x6 36x6 36x6	6 to 1	6500 6000 6400	42 42 42	33 37 41	33 36 36	Despite Despoil Despond
8	10 12	4 6	6 6	1.30 2.04 3.44	40 40 40	52.3 81.6 137.9	300 200 300	30x5 36x6 36x6		3600 4000 6300	44 49 62	43 51 71	39 48 64	Despot Destiny Detract
				5.00 7.83	40 35	200.0 300.0	300 300	42x6 48x8	6 to 1	14600 18000	105 115	86 93	87 96	Devest Devoid

Any of these pumps will be furnished with extension base to receive motor and with gear and armature pinion instead of tight and loose pulleys when desired. Prices on application.

House Tank Pump.

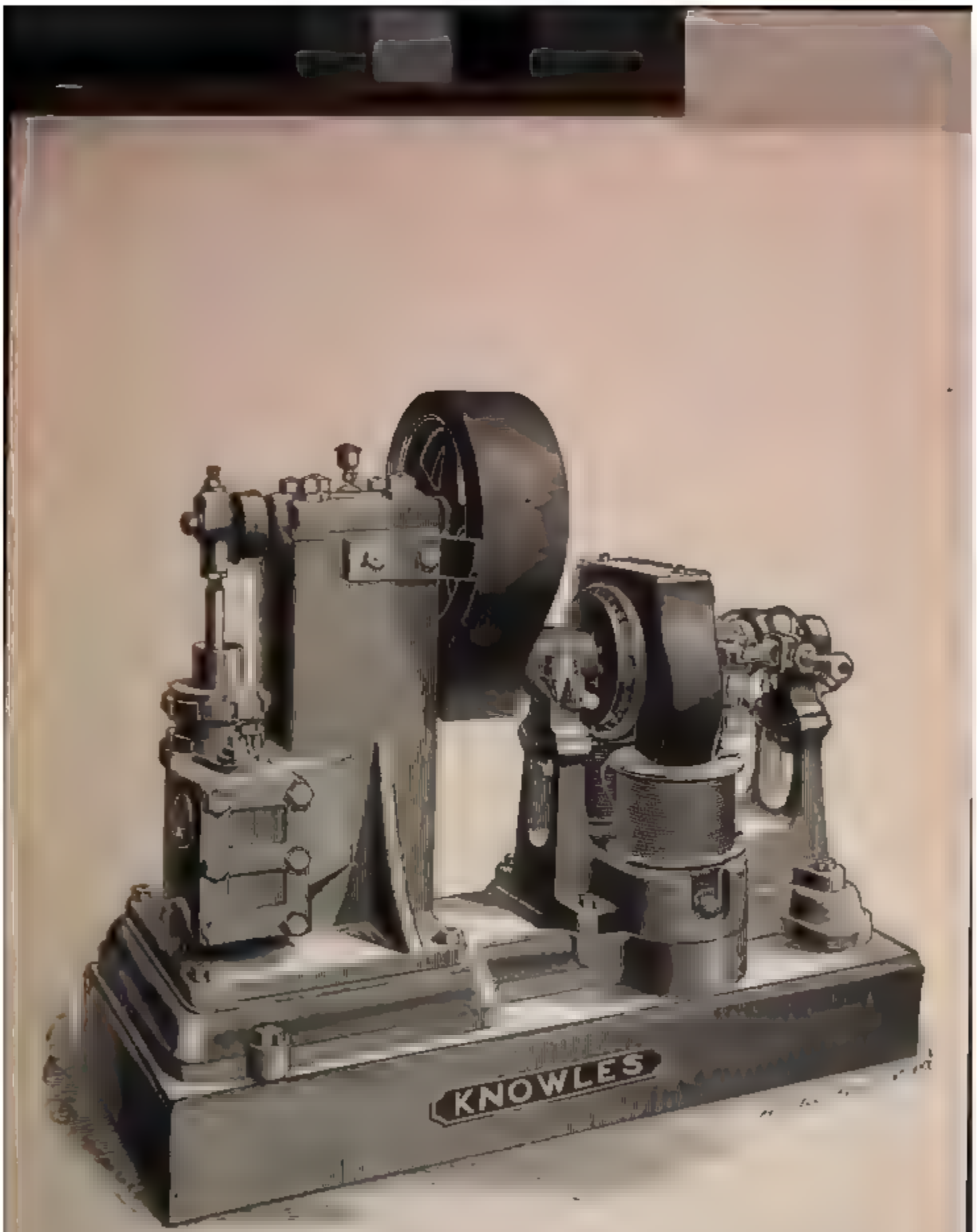
REALIZING the demand for a cheap, compact, efficient and reliable pump of small capacity for house and public building service, we some time ago designed the apparatus shown on the opposite page, to meet these special conditions.

Wherever the pressure on the street mains is not sufficient to carry the water above the lower stories, a device of this kind is the most economical that can be used in a supplementary capacity, and is indeed the only one which has proven its reliability for long service without skilled attention when arranged to work automatically.

A special low speed motor is used, with rawhide pinion and cut gear, covered by a japanned iron guard The shaft runs in an extra long babbited bearing, carried by a hollow pedestal which serves as an air chamber, thus equalizing the pressure on discharge pipe, and securing a uniform flow. The plunger rod has a composition head, is hung on a heavy crank pin set in a disc on end of shaft, and has a throw of 1½ inches.

The plunger is single acting, but of the differential type, so that the same amount of water is forced through the delivery valve on the up as on the down stroke, thus securing remarkable uniformity of action as compared with most single plunger pumps. First quality rubber valves only are used, working on composition valve seats, and the entire construction is equal in materials and workmanship to our larger size standard pumps. For tank service in public and private buildings we usually furnish these pumps complete with electric speed controller and automatic switch, to be operated by a float in the tank so that the pump will start and stop automatically as the water level varies between predetermined limits. The capacity specified is for a maximum lift of from 100 to 150 feet, but a higher pressure may be obtained by the use of a larger motor and special gears

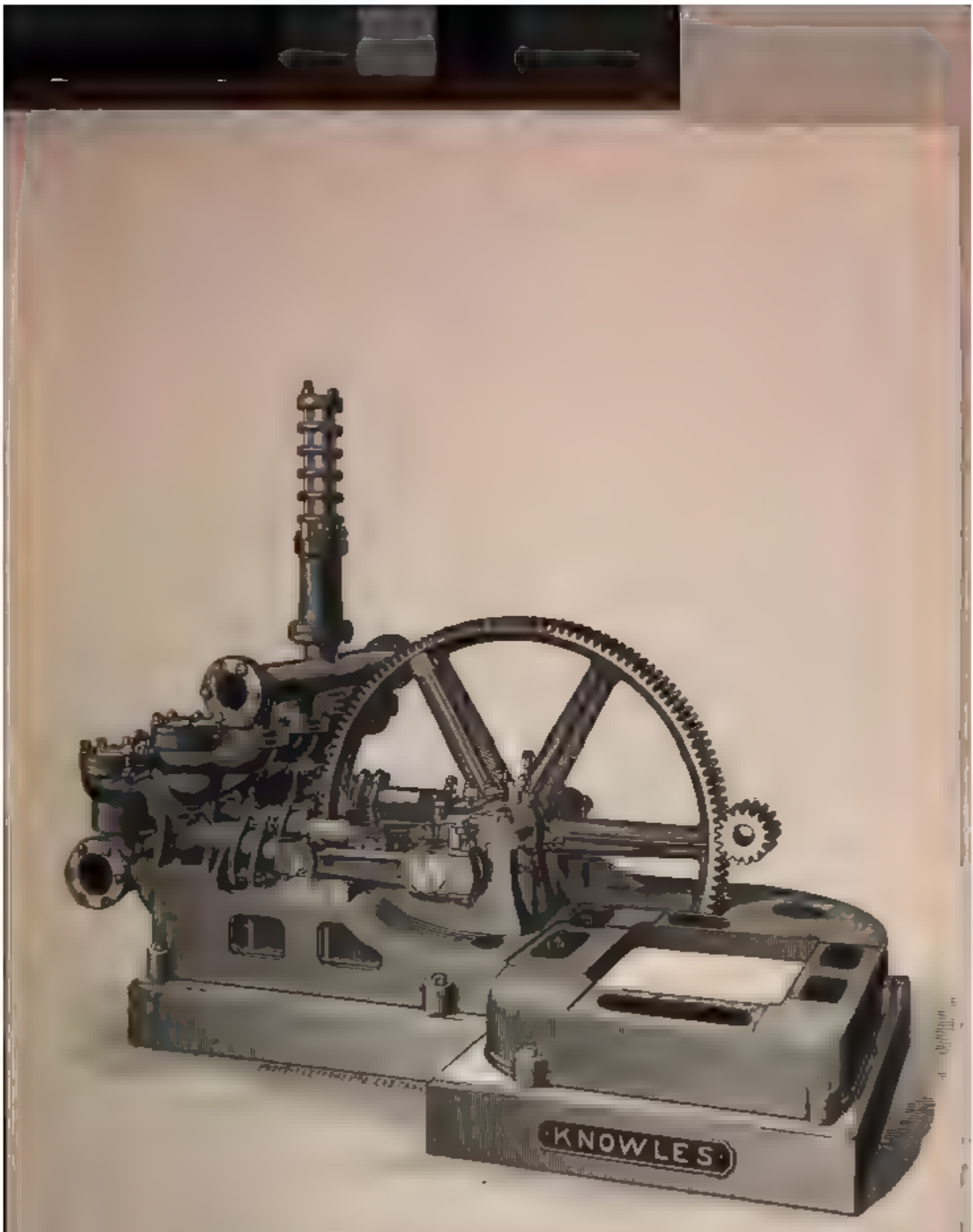
Diam.'s of Plungers.	*Stroke*	*Rev per Minute*	*Gal per Revolution*	*Gal per Minute*	*Suction.*	*Discharge.*	*Ratio of Gearing*	*Weight Complete*	*Over all*			*Price*	*Code word (Complete with motor)*
									Height.	*Width.*	*Depth.*		
2½	1½	170	04	7	1¼	1	3 5	530	27¾	15½	35¾		Deride



"House Pattern," Differential Plunger Pump.

THE cut on the opposite page shows our improved horizontal triplex pump, with single acting plungers, complete with extended bed plate for operation by an electric motor. This design is specially intended for mining work and general service in which pressures of from 200 to 600 lbs. are necessary, and is provided with "pot" valves of the latest pattern. Power is transmitted from the motor to the plunger shaft by a single cut gear and pinion, thus reducing the working friction to a minimum, and making an extremely compact piece of apparatus. As in our vertical triplex pumps, the supply and discharge pipes may be located on either side. A special form of relief plunger is used instead of the usual form of air chamber.

Diam. of Cylinders	Stroke	Suction.	Discharge	Rev. per Minute.	Gallons per Revolution	Gallons per Minute.	Maximum Lift in Feet	Ratio of Gearing	Weight Ready for Motor	H. P. of Motor	Weight Complete	Height.	Width.	Depth.	Price	Code Word.
3	6	3	2	74	.55	40	1250	8.78	Lbs. 7100	20	9735	6 8"	6' 7"	8' 8"	.....	Docile.
4	6	4	3	74	.99	72	750	"	7100	"	9735	"	"	"	.....	Dolphin.
4½	6	5	4	74	1.38	103	500	"	7145	"	9780	"	"	"	.....	Donate.
5	6	5	4	74	1.52	112	440	"	7240	"	9905	"	"	"	.....	Dotage.
5½	8	6	4	58	2.47	143	750	9	14445	50	19945	8' 1"	7' 11	11 2"	....	Dowel.
6	8	6	5	58	2.04	162	600	"	14540	"	20400	"	"	"	....	Dormer.
6½	8	6	5	58	3.45	201	550	"	14845	"	20745	"	"	"	.....	Dough.
7	8	6	6	58	4.0	232	500	"	15150	"	51060	"	"	"	.....	Doxy.



Horizontal Triplex Electric Power Pump.

With Single Acting Outside Packed Plungers.

Horizontal Simplex Electric Power Pump.

Double Acting Piston Pattern.

WHILE the duplex or triplex form of pump is usually preferable for operation by electric power, we are prepared to furnish single piston apparatus whenever desired by our customers, of any capacity specified. The form shown above is especially rigid and substantial, owing to the massive form of the bed plate, to which all parts of the mechanism are attached. Full particulars and prices for every variety of service will be given on application.

Horizontal Triplex Pumps.

Double Acting Plunger Pattern.

IN RESPONSE to the rapidly increasing demand from mining and hydraulic engineers for a standard line of electrically operated pumps suitable for heavy service, and thoroughly up to date in every respect, we have designed the apparatus shown on page 27, and are now ready to furnish any of the sizes specified, ranging from 300 to 2,000 gallons per minute in capacity, and for pressures up to 275 lbs.

Any of the standard sizes given in the table may of course be modified by slight changes in proportions to meet the requirements of any special service.

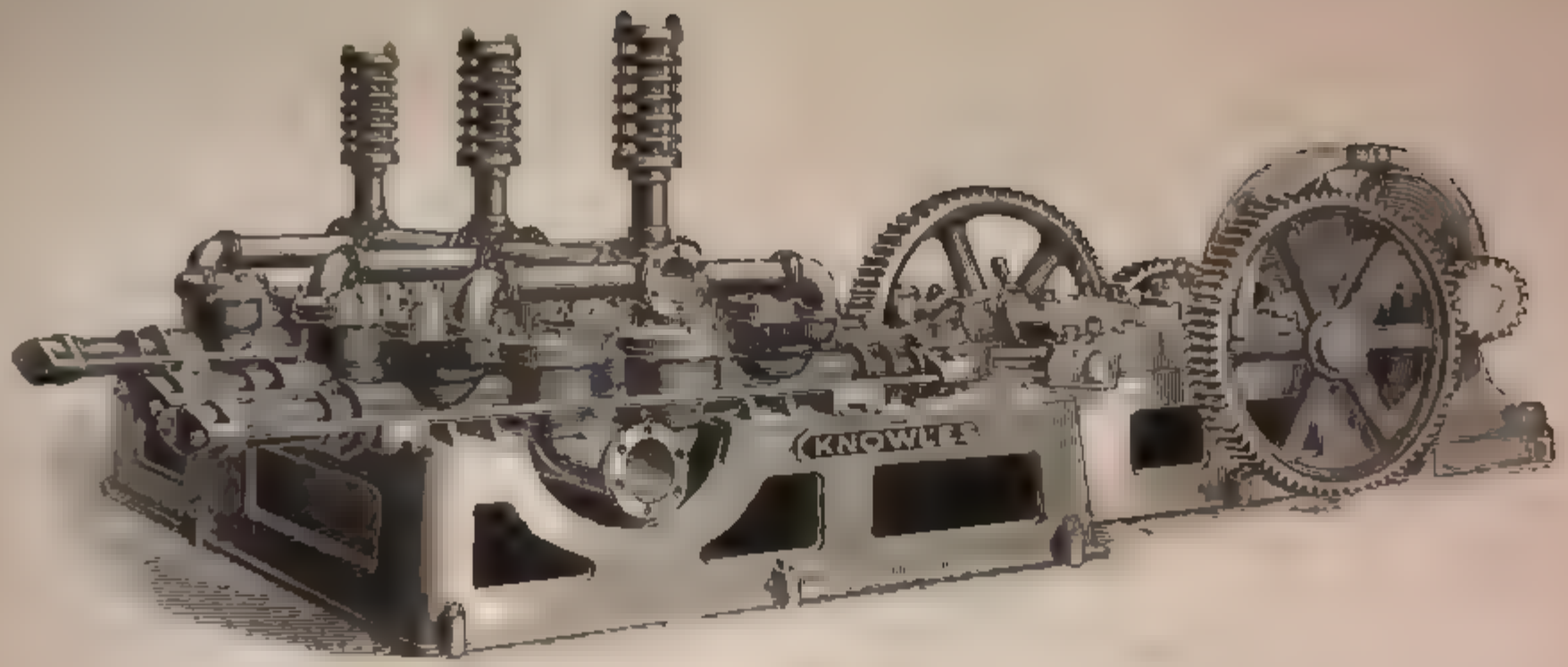
The construction throughout is of the most durable and massive character consistent with facility of inspection and adjustment.

The motor is placed at one end of a girder type bed plate, the power being transmitted to the crank shaft by heavy intermediate cut gearing. The plungers are driven by locomotive-type connecting rods with ample wear adjustments. The latest pattern "pot" valves are used, and the usual type of air chamber is replaced by specially designed cushion plungers or "alleviators" for equalizing the water flow.

The comparative economy of installation and maintenance, as well as the increased safety and convenience of operation of this type of pumping apparatus especially recommends it for heavy lifts in general mining and hydraulic work, where the use of steam pipes is objectionable on account of limited space or liability to mechanical injury and consequent leakage.

Diam. of Cylinders	Stroke	Suction.	Discharge.	Revolutions per Minute.	Gallons per Acre dilution.	Gallons per min.	Manimum Lift in feet	Ratio of Gearing	Weight ready for Motor	H P of Motor
5	12	6	5	50	6 12	306	630	12	33,000	75
5½	12	6	6	"	7 4	370	520	12	34,100	"
6	12	8	7	"	8 81	440	430	12	34,500	"
6½	12	8	7	"	10 34	517	370	12	34,800	"
7	12	10	8	"	12 86	643	300	12	35,100	"
8	12	10	8	"	15 66	783	240	12	36,500	150
9	12	10	8	"	12	600	600	12	48 000	"
10	12	12	10	"	15 66	783	460	12	48 500	"
10	12	12	10	"	19 83	991	360	12	49,000	"
10	12	12	10	"	24 48	1,224	300	12	50 000	"
10	18	12	10	33	36 72	1 211	300	18	65,000	"
10	18	14	12	40	36 72	1,468	500	12 5	115,000	300
11	18	14	12	"	44 43	1,777	400	12 5	119,000	"
12	18	16	14	"	52 78	2,111	340	12 5	120,000	"

Weight Complete.	Over all. Height.	Width.	Depth.	Price.	Code Word.
39,300	9 0	9 3	24 0		Dragon.
40,300	9 0	9 3	24 0		Drama.
40,800	9 0	9 3	25 11		Dreamy.
41,100	9 0'	9 3	25 0		Driblet.
41,300	9 0	9 6	25 6		Drivel
42,800	9 0	9 6	25 6		Drizzle.
63,000	9 6	10 5	27 7		Dropsy
63,500	9 6	10 5	27 7		Drudge.
64,000	9 8'	10 11	27 7		Drugget.
65,000	9 8	10 11	27 7		Drummer.
80 000	9 8	10 11"	29 4'		Droop.
145,000	10 5'	11 8	33 9		Droll.
149,000	10 5'	11 8	33 9"		Drone
150,000	11 3'	12 5	34 3		Drench.



Horizontal Triplex Electric Power Pump.

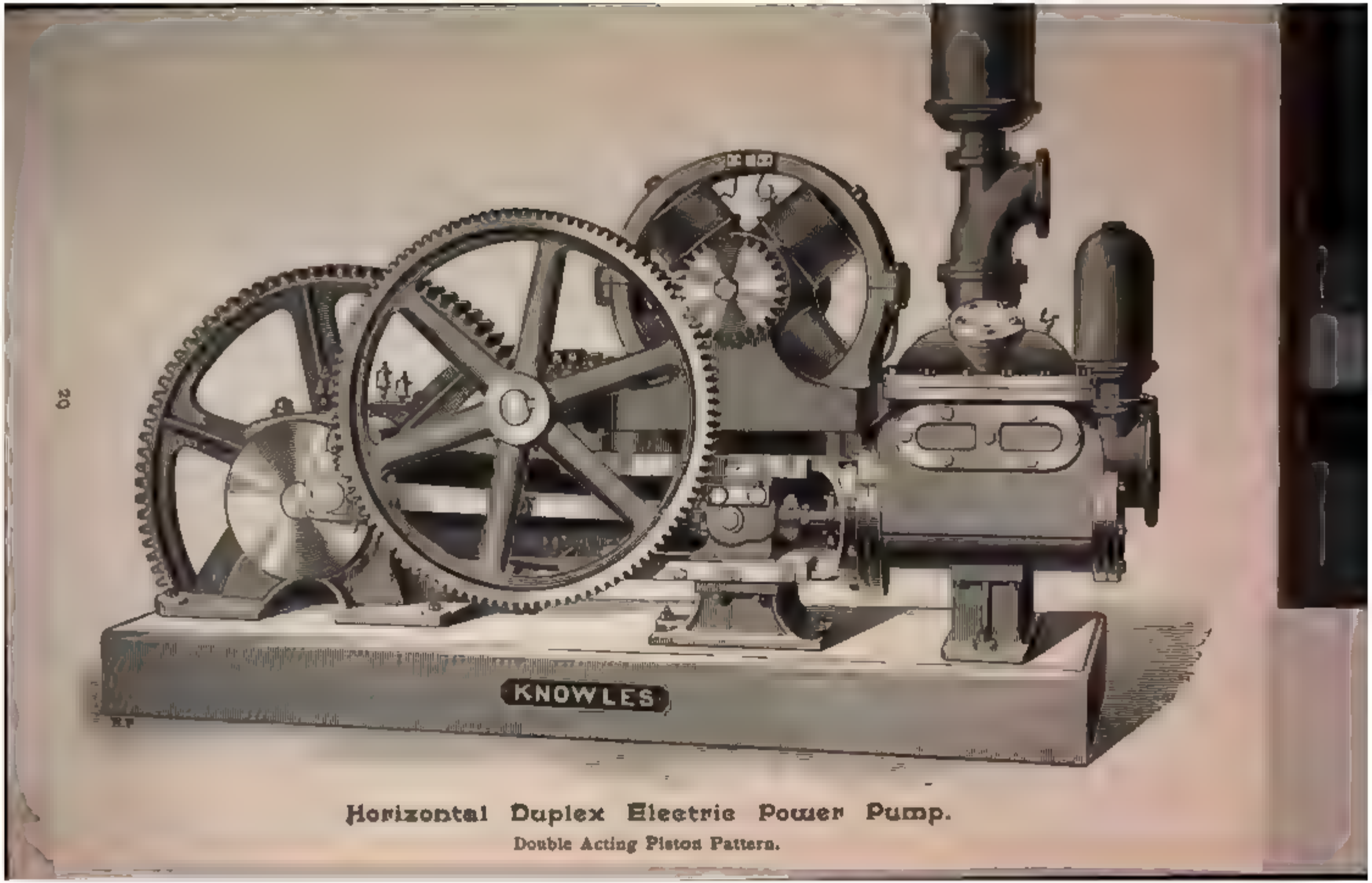
With Double Acting Outside Packed Plungers. For description see page 25.

Horizontal Triplex Pumps.

PUMPS of the horizontal duplex pattern, with double acting pistons, as illustrated on the opposite page, are exceedingly compact and efficient, and may often be used to advantage instead of the triplex form with single acting plungers. The size shown in the cut has 8-inch pistons, with a stroke of 12 inches, and is driven by a 40 H. P. motor. The gears are machine cut, the connecting rods extra long, with all usual adjustments for wear, and the entire apparatus is first class in every respect. Owing to the peculiar design of this type of pump it is desirable to spread the cylinder and auxiliary parts to correspond with the shape and speed of the motor used, while the size of cylinders may be varied to suit circumstances. We therefore omit the usual table of "standard" sizes, preferring to submit specifications in accordance with the nature of the service intended.

Pumps for Elevator Service.

OWING to the compensating action of the pistons, the duplex and triplex pumps shown in these pages are especially adapted for hydraulic elevator service, either with a series wound motor arranged to start and stop automatically as required by the varying pressure or level in the supply tanks, or provided with a by-pass and automatic controlling valve, allowing the motor to run uninterruptedly. This plan is to be preferred whenever a practically continuous service is to be provided for, as it avoids the excessive wear and tear of frequent starting on switches and rheostats, while the increased economy of a constant speed motor more than compensates for the slight loss of power required to pump through the by-pass loop during "full-pressure" intervals. Diagrams showing method of connecting up and wiring for either system will be furnished customers whenever desired.



Horizontal Duplex Electric Power Pump.

Double Acting Piston Pattern.

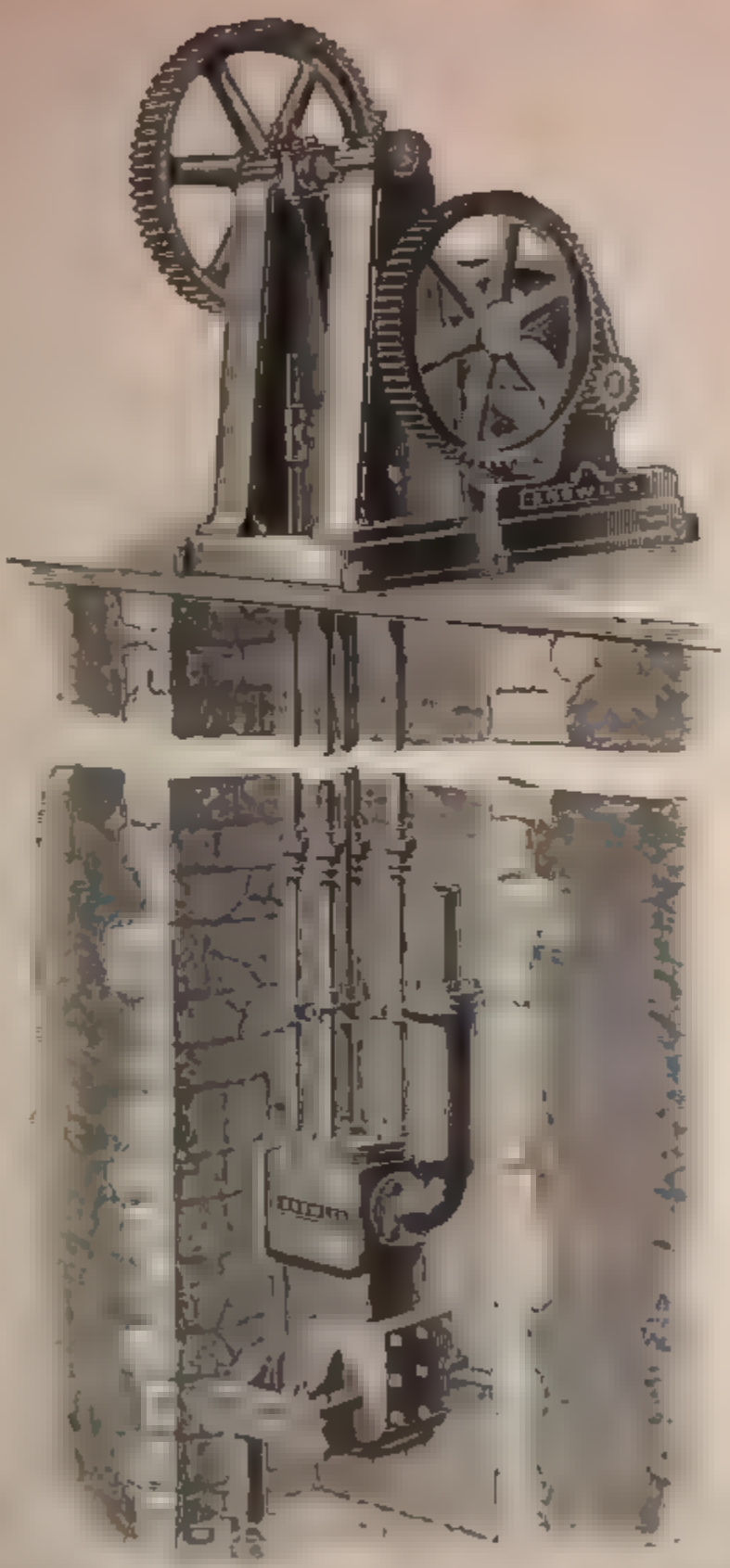
Deep Well Pumps.

FOR well pumping, or any service requiring the steam and pump cylinders to be placed some distance apart, the general type of pump shown on the opposite page is recommended This apparatus may be modified to suit a wide range of requirements, the "working head" being made of the vertical pattern, as illustrated, or of the horizontal type, with heavy cast iron bed plate to which the guide frame and discharge pieces are bolted It may also be fitted with tight and loose pulleys, for belting from any available source of power, instead of "direct-connected," and may be arranged to drive two or three separate plungers, forming a duplex or triplex deep well pump, suitable for use in ordinary open wells The shaft, connecting rod and bearings are all heavy and designed for severe service, the gears are machine cut, and the tie rods and guides proportioned to the work to be performed.

The water cylinder is double-acting, so that a steady, continuous stream of water is delivered The lining, piston rod, stuffing box, valve seats, valve bolts, etc., are made of the best composition. The water piston is also made of composition and arranged with adjustable packing, making the water end practically "rust proof."

Estimates will be promptly furnished for any desired combination of water and power ends on receipt of the necessary information as to capacity, distance of water level below surface, working head, space available in well, etc.

Diam Water Cylinder.	*Stroke*	*Suction Opening.*	*Discharge Opening*	*Gallons per Revolution*	*Gal per min at 100 ft. Piston Travel.*	*Working Head.*	*Price.*	*Code Word.*
[illegible]	[illegible]	[illegible]	1[illegible]	96	66	Built for total lifts of from 20 to 250 feet.		Dicker.
[illegible]	[illegible]	3	3[illegible]	1 20	82			Dilate.
[illegible]	12	3	3[illegible]	1 44	99			Disarm.
[illegible]	12	3[illegible]	3	1 04	82			Disjoin.
[illegible]	12	3	3	1 94	118			Distend
[illegible]	12	4	4	4 00	160			Divan.
6	16	3[illegible]	3	3 92	118			Diadem
[illegible]	16	4	3[illegible]	5 33	160			Diction
8	16	5	4	6 96	209			Digest.
9	16	5	4	8 81	264			Discern.
10	16	8	6	10 88	326			Divorce.



Electrically Operated Deep Well Pump.

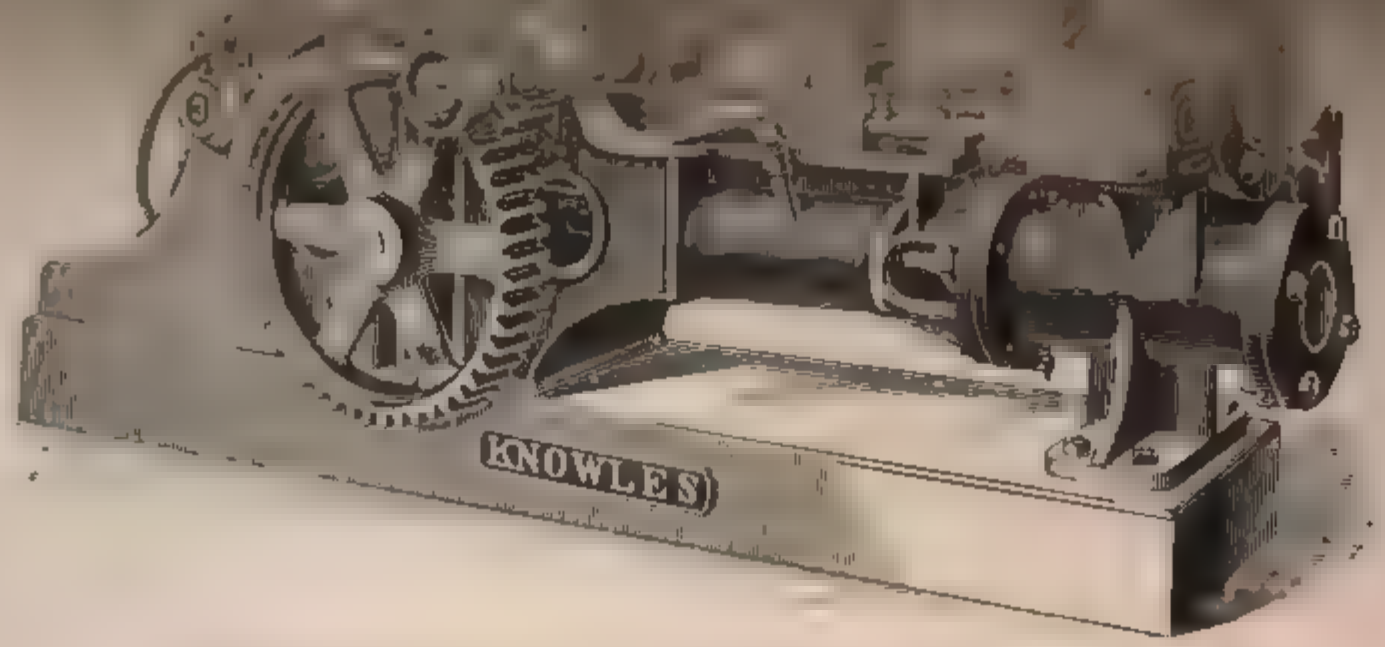
Double Acting Piston Pattern

Duplex Mine Sinking

THE Demand for a Mine Sinking Pump at once in form, of good capacity and efficiency, moisture or hard usage, has been met opposite page, in which a special form of motor ing and operating mechanism in an absolutely Although the only moving parts visible are sh rods, every part of the motor and pump (whic packed plunger type) is readily accessible for e apparatus is designed to stand more hard usage w of sinking pump in the market, and as the well under water as out; in fact the cooling advantage than otherwise, and if properly pump may be completely "drowned" by a mine without in the least affecting its operation, the motor itself is enclosed in a second that containing the entire apparatus, so that ev or injured so as to cause a leak, the pump would

he same general advantages over steam case as in the stationary types, but with even convenience in lowering and raising in the shaft steam pipes and escaping steam under all circ case of accident. The standard sizes given desired for special capacities or greater lifts.

Diam Plunger.	*Stroke.*	*H. P. of Motor.*	*Gal. per Stroke Each Plunger.*	*Gal. Capacity per min. at Ordinary Speed*	*Vertical Head in feet.*	*Suction.*	*Delivery.*	*Dimensions of Hall*
4	6	10	32	100	100	4	3	24x24
5½	8	15	78	150	100	5	4	28x40
6¼	8	20	1 14	250	100	6	5	30x48x1



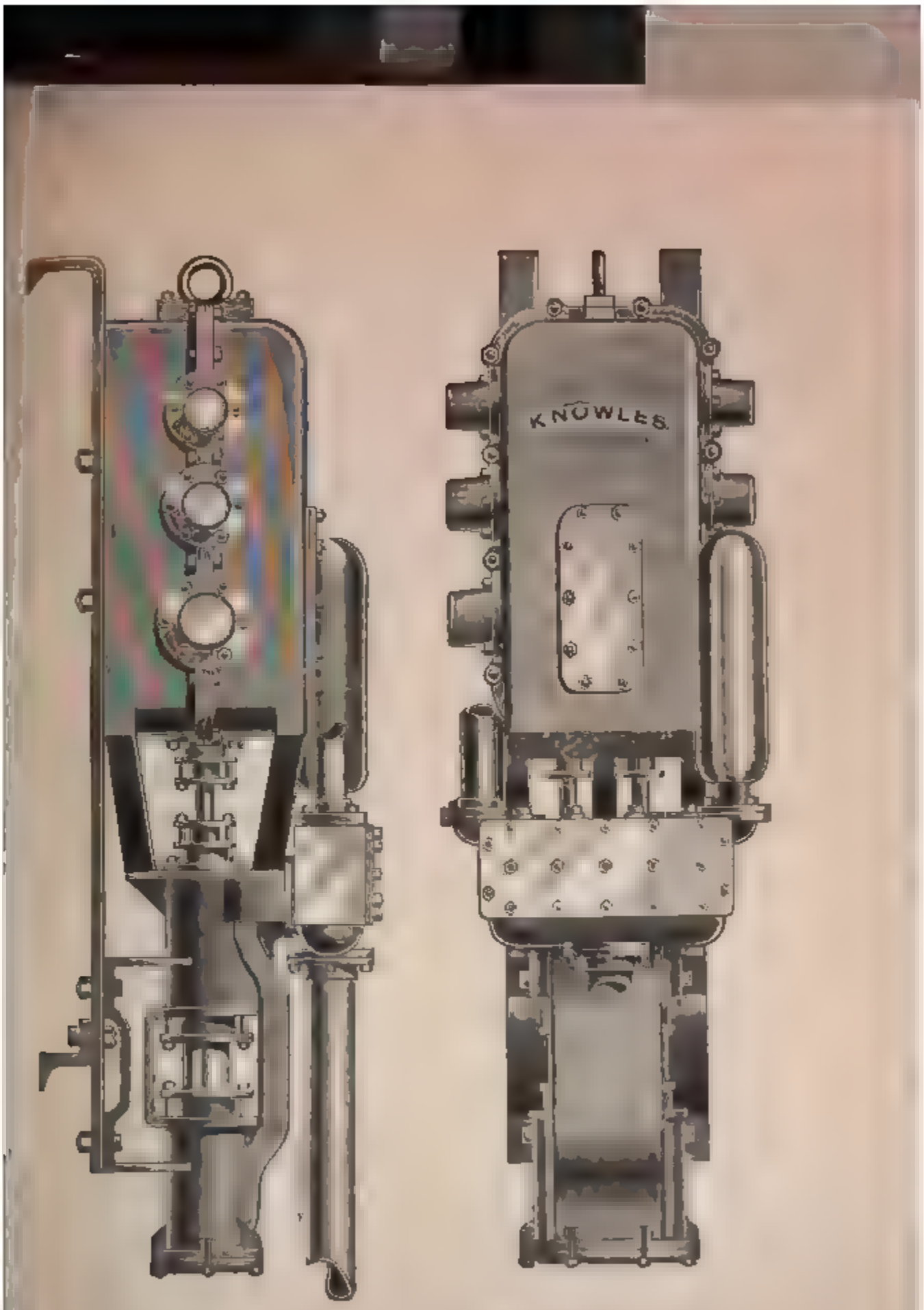
Combined Steam and Electric Power Pump.

Duplex Mine Sinking Pump.

THE Demand for a Mine Sinking Pump at ouce light in weight, compact in form, of good capacity and efficiency, and not liable to damage from moisture or hard usage, has been met by the design shown in the opposite page, in which a special form of motor is used, encased with its gearing and operating mechanism in an absolutely water-tight steel casing. Although the only moving parts visible are short sections of the plungers and rods, every part of the motor and pump (which is the double-acting outside packed plunger type) is readily accessible for examination or repairs. his apparatus is designed to stand more hard usage without injury than any type of sinking pump in the market, and as the case is water-tight will work as well under water as out; in fact the cooling action of the water is rather an advantage than otherwise, and if properly insulated cables are used the pump may be completely "drowned" by a sudden inrush of water in the mine without in the least affecting its operation. As an additional precaution, the motor itself is enclosed in a second waterproof chamber, inside that containing the entire apparatus, so that even if the latter were broken or injured so as to cause a leak, the pump would not necessarily be crippled

he same general advantages over steam-operated pumps apply in this case as in the stationary types, but with even greater force, owing to the convenience in lowering and raising in the shaft, and the freedom from hot steam pipes and escaping steam under all circumstances, but especially in case of accident. The standard sizes given below may be modified as desired for special capacities or greater lifts.

Diam. Plunger.	*Stroke*	*H P of Motor.*	*Gal. per Stroke Each Plunger*	*Gal. Capacity per min. at Ordinary Speed*	*Vertical Head in feet*	*Suction.*	*Delivery.*	*Dimensions over all.*	*Approx. Weight.*	*Price.*	*Code Word. (Complete with Motor)*
4	6	10	32	100	100	4	3	24x24x 84	3,500		Ducat.
5	8	15	78	150	100	5	4	28x40x108	5,200		Duel.
6	8	20	1 14	250	100	6	5	30x45x114	7,000		Dunce.



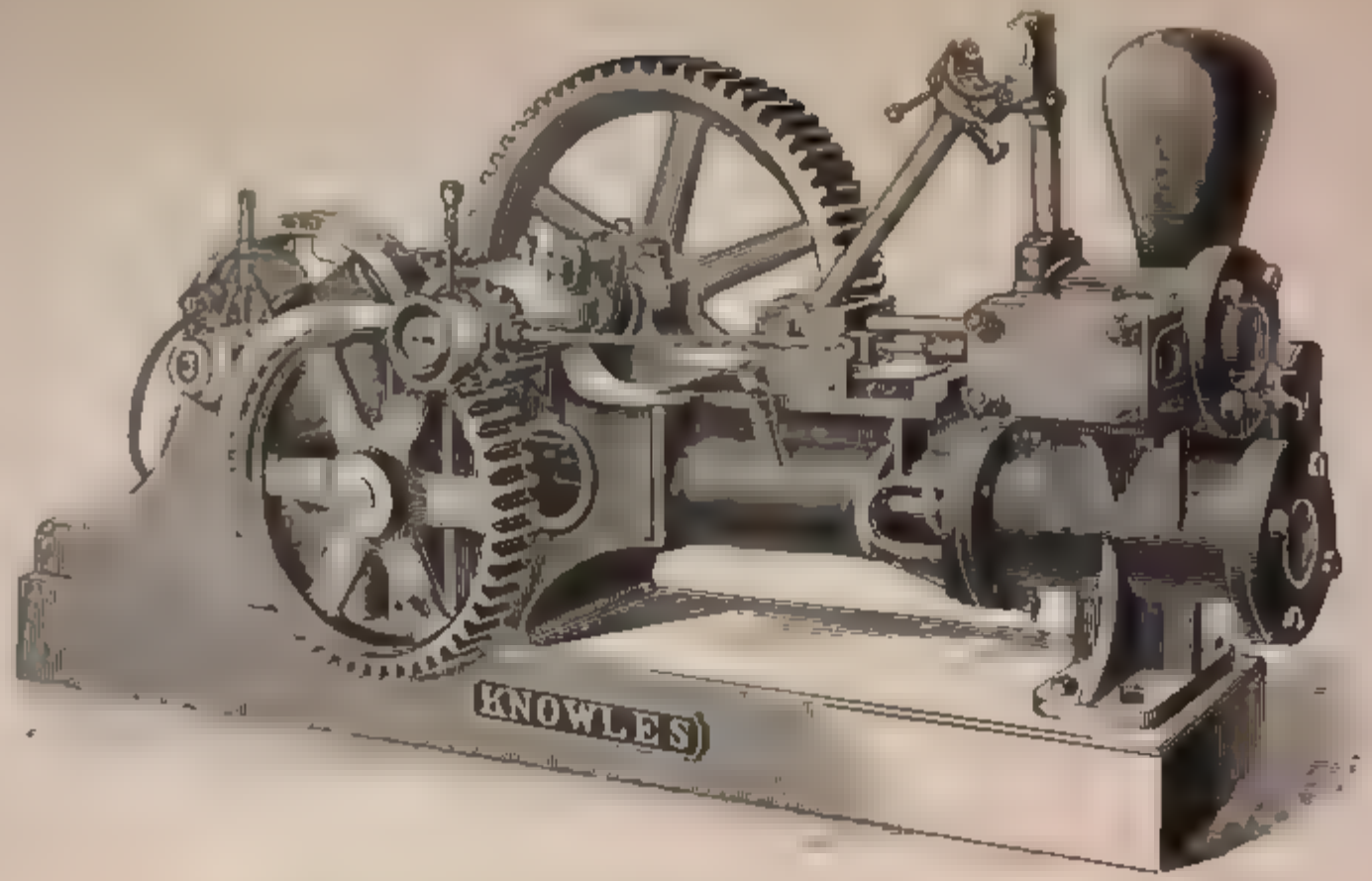
Duplex Electric Mine Sinking Pump.

Special Apparatus.

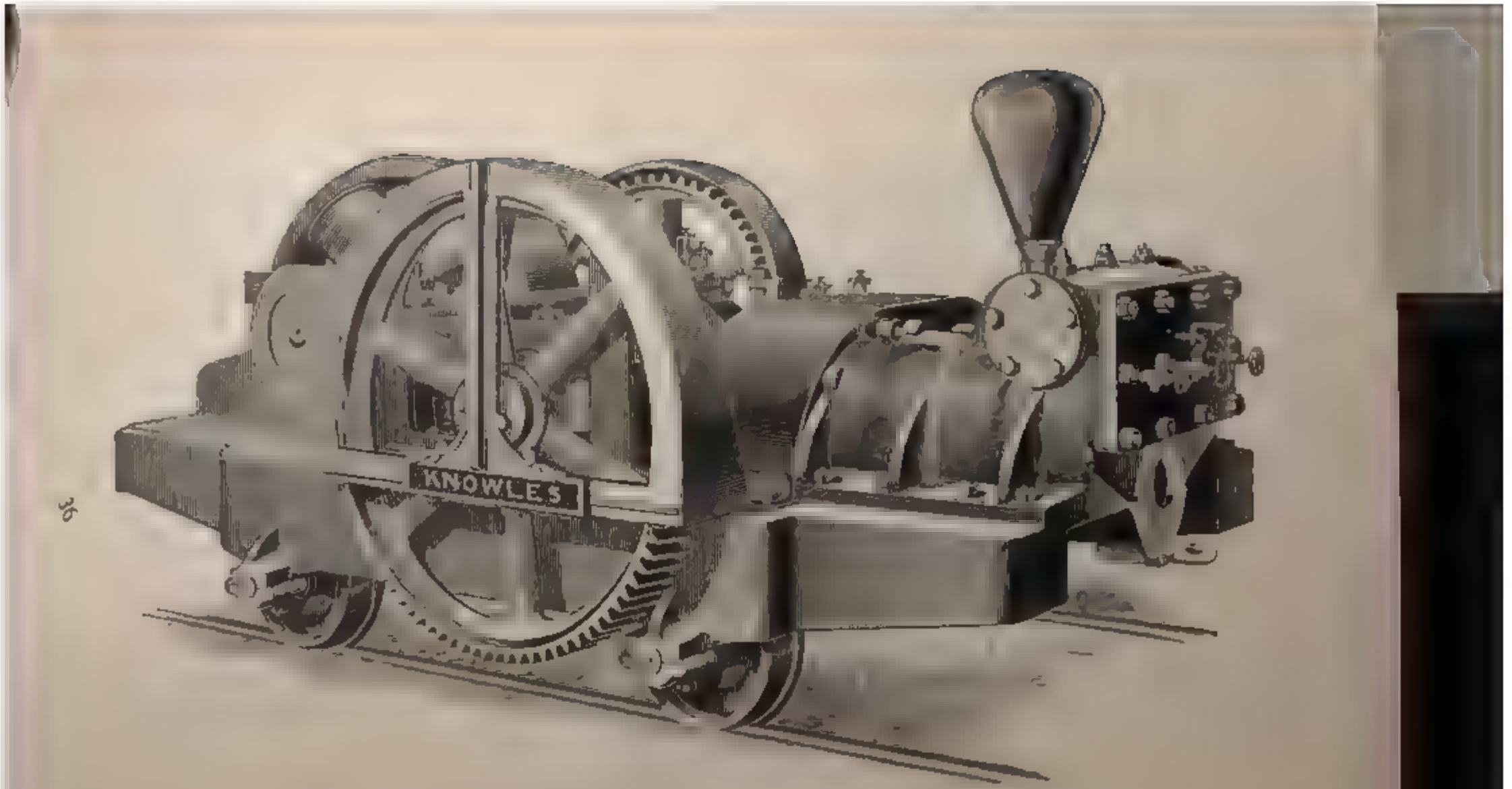
ON pages 35 and 36 we illustrate two of the many special types of apparatus which we have from time to time built for our customers, to meet the exigencies of peculiar conditions and surroundings. Their introduction in these pages is intended less as a suggestion to those interested in engineering problems, than to illustrate the facility with which our manufacturing resources may be drawn upon to meet the demands of all classes of purchasers. We are ready at any time to prepare specifications, plans and estimates on pumping apparatus for any possible service.

Combined Steam and Electric Power Pump . . . This apparatus is specially adapted to locations where steam is required only part of the time, for heating or power purposes, while pumping must be carried on continuously, and electric power is available for use in the intervals. The connecting rod is designed to be quickly connected or disconnected, cut gears are used throughout, and the cross heads made with a special take-up for lost motion. Crank-shafts are carried in large babbited bearings. The size illustrated has a steam cylinder 4½ inches in diameter, the water cylinder being 3¾ inches and stroke 6 inches.

Portable Mine . . Pump . While designed primarily for mining service, this apparatus will be found exceedingly convenient and economical for excavating and contracting purposes, where a pump must be moved at frequent intervals to keep pace with the progress of the work. The illustration shows a pump having three plungers 6½ inches diameter and 8-inch stroke, driven by a 10 H. P. motor. Many modifications and special forms of this type of apparatus will suggest themselves to mining and hydraulic engineers.



Combined Steam and Electric Power Pump.



Triplex Portable Electric Power Mine Pump.

With Single Acting Outside Packed Plungers.

For description see page 54.

Power Allowance Table.

This table has been compiled with the utmost care, from data based on special tests and obtained under actual working conditions, and shows the amount of mechanical power which should be provided for the successful operation of the standard sizes of Triplex Pumps, operating under various pressures in ordinary service. In using this table it should be borne in mind that the pressure assumed for computation should cover not only that actually due to "working head" (*i. e.*, the vertical distance between suction and discharge levels), but also the "friction head," or loss due to friction in the discharge pipes. (See page 42.)

For electrical operation a motor of ample capacity should always be provided, not on the basis of *average service*, but sufficient to supply without overloading the *maximum power* which could ever be required of it.

This table is applicable to any well built power pumps of similar capacity, and working under corresponding pressures.

Diam. and Stroke.	*Capacity in Gallons per minute at 40 Revolution.*	*Power Allowance for 25 lbs. pressure. (H. P.)*	*Power Allowance for 50 lbs. pressure. (H. P.)*	*Power Allowance for 75 lbs. pressure. (H. P)*	*Power Allowance for 100-125 lbs. press. (H. P.)*
4 x 6	40	1.5	2.	2.5	4.5
5 x 6	61	1.75	3.	3.5	6.
5 x 8	82	2.5	4.	5.	8.5
6½ x 8	138	3.5	5.	7.	13.
8 x 8	210	5.25	8.	10.	18.
8 x 10	261	7	10.5	14.	25.
8 x 12	314	8.	12.	16.	28.
9 x 10	330	8.25	13.	17.	30.
9 x 12	400	10.	18.	25.	35.
10 x 12	490	12.	20.	30.	45.
10 x 12	592	14.	24.	35.	55.
12 x 12	705	15.	28.	40.	65.
13 x 13	827	17.	30.	45.	70.

TELEGRAPHIC CODE.

FOR ORDERING PUMPS OR PARTS OF PUMPS.

INQUIRIES.

Aback Have you for immediate shipment?

Acute About when can you ship?

Adopt What is the *quickest* possible time in which you can ship?

Ailing When did you ship?

Akron By what line did you ship?

Ascent Shall we ship Ex or Freight?

Afar State price and time to deliver Pump of the following dimensions:

Agent .State dimensions, price and time to deliver a Pump for following duty.

Alarm Is Pump for hot or cold water?

Amber Is Pump for mash or clear beer?

Ancient .Is Pump for liquor or extract?

Anvil Is Pump for clear or gritty water?

Apex What kind of liquid is to be pumped, and what quantity per minute?

Apeak Is Pump to have pump cylinder made entirely of composition?

Arab Is Pump old or new style?

Artist What is shop number?

Attack What is the matter with Pump?

August Is it the steam cylinder or water cylinder that is out of order?

Auger What is size and length of suction pipe, and what is vertical suction?

Avoid How long and what is the size and height of delivery pipe?

Axis .What is the steam pressure?

Awful .What pressure per square inch is pump to force against?

Awning. . Is there acid or grit in water?

Awake What is the vacuum on suction?

ANSWERS TO INQUIRIES.

Bacon. . We have on hand for immediate shipment.

Begin .We can ship to-morrow.

Bewail We can ship next week.

Bible We can ship on the

Blotter We cannot ship before

Body .We shipped on the

Broker We shipped by

Brocade We would recommend a Pump of following dimensions

Booklet Pump is old style and its shop number is

Brutal Pump is new style and its shop number is

Brother For Hot Water.

Buckle For Cold Water.

Bugle For Thick Mash.

Business For Clear Beer.

Button For Tan "Liquor."

Burden For Tan "Extract."

Briny If it is desirable.

Boiler The Pump will not start when steam is turned on

Border .The Pump works, but will not give any water

Blunder There is vacuum on suction pipe of ....inches

Burrow Will pump. ....gallons of .....per minute.

Butler. . Will force against . .pounds pressure.

Bundle .Will lift water .....feet by suction.

Burnish Special apparatus, will advise later by mail.

[redacted]

ORDERING.

Camel..Ship by Express.
Central..Ship by Fast Freight Line.
City..Ship by Ex. to-day without fail.
Climate..Ship by Fast Freight this day without fail.
Coffee..Ship by regular Freight.
Croton..Ship by Canal.
County..Ship by Steamer.
Cradle..Ship by the first Steamer sailing.
Custom..Ship by Sailing Vessel.
Cover..Ship immediately.
Crusty..We are in a great hurry—Important!

Special Phrases for Electric Pumps.

Eager	Complete with	¼	H	P.	motor.
Earnest	"	"	½	"	"
Easel	"	"	1	"	"
Eatable	"	"	2	"	"
Ebony	"	"	3	"	"
Echo	"	"	4	"	"
Eclipse	"	"	5	"	"
Ecstasy	"	"	7½	"	"
Eden	"	"	10	"	"
Edible	"	"	15	"	"
Edict	"	"	20	"	"
Edify	"	"	25	"	"
Editor	"	"	30	"	"
Efface	"	"	35	"	"
Effect	"	"	40	"	"
Effigy	"	"	50	"	"

Effort..For 110 volt direct current.
Egress.. " 220 " " "
Eject.. " 500 " " "
Elapse.. " 50 volt alternating current.
Elastic.. " 100 " " "
Elbow..One phase.
Elector..Two "
Elegy..Three "
Elite..Of 8,000 alternations per minute.
Elixir.. " 16,000 " " "
Elope..Provided with automatic electric controller, operated by change of water level in tank.
Elude..Provided with by-pass and automatic valve, for closed tank system.

Note.—Unless specially stated otherwise, code names of pumps in this Catalogue refer to them *without* motors or controlling devices, which must be specified as provided above.

Useful Information.

DOUBLING the diameter of a pipe increases its capacity four times. Friction of liquids in pipes increases as the square of the velocity See table of "friction of water in pipes," on page 42.

The mean pressure of the atmosphere is usually estimated at 14.7 lbs per square inch, so that with a perfect vacuum it will sustain a column of mercury 29.9 inches or a column of water 33.9 feet high at sea level.

To find the pressure in pounds per square inch of a column of water multiply the height of the column in feet by .434. Approximately we say that every foot elevation is equal to ½ lb. pressure per square inch this allows for friction of water flowing through pipe at ordinary velocity

To find the diameter of a pump cylinder to move a given quantity o water per minute (assuming 100 feet of piston travel at the rate of speed, divide the number of gallons by 4, then extract the square root, and the product will be the diameter in inches of the pump cylinder.

To find quantity of water elevated by a pump in one minute running at say 100 feet of piston speed per minute, square the diameter of the water cylinder in inches and multiply by 4. Example: Capacity of a 5 inch cylinder is desired. The square of the diameter (5 inches) is 25, which multiplied by 4, gives 100, the number of gallons per minute (approximately)

To find the horse-power necessary to elevate water to a given height multiply the weight of the water elevated per minute in pounds by the height in feet, and divide the product by 33,000. (An allowance should be added for water friction, etc., say from 20 to 30 per cent.)

The area of the Steam Piston of a steam pump, multiplied by the steam pressure, gives the total amount of power in pounds that can be exerted. The area of the water piston, multiplied by the pressure of water per square inch, gives the resistance A margin must be allowed between the power, and the load or resistance to move the pistons at the required speed, say of from 15 to 25 per cent. according to the speed and other conditions.

To find the capacity of a cylinder in gallons. Multiply the area in square inches by the length of stroke in inches to find the total number of cubic inches; divide this amount by 231 (which is the measure of a U. S. gallon in cubic inches), and product is the capacity in gallons.

For fresh water, the standard U S gallon weighs 8.33 lbs ,and there are 7 48 gallons to the cubic foot. The Imperial (English) gallon of fresh water weighs 10 lbs., contains 277.27 cubic inches, and there are 6 23 gallons to the cubic foot.

Crude or refined petroleum weighs about 6½ lbs. per U. S. gallon.

A "miner's inch" of water is about equal to a supply of 12 U. S. gallons per minute.

WROUGHT IRON WELDED PIPE.

Dimensions, Weights, Etc., of Standard Sizes for Steam, Gas, Water, Oil, Etc.

1 in. and below are butt-welded, and proved to 300 pounds per square inch hydraulic pressure.
1¼ in. and above are lap-welded, and proved to 500 pounds per square inch hydraulic pressure.

Inside Diameter	Outside Diameter.	External Circumference.	Length of Pipe per sq. ft. of Outside Surface.	Internal Area.	External Area.	Length of Pipe containing one Cubic foot	Weight per foot of Length	No. of Threads per in. of Screw.	Contents in *Gallons per foot	Weight of Water per foot of Length.
Inch	Inches	Inches	Feet	Inches	Inches	Feet	Lbs			Lbs.
⅛	.40	1 272	9 44	.057	.129	2500	.24	27	.0006	.005
¼	.54	1 696	7 075	.104	229	1385	.42	18	.0026	.021
⅜	.67	2 121	5 657	.191	.358	751 5	.56	18	.0057	.047
½	.84	2 652	4 503	.304	554	472 4	.84	14	.0102	.085
¾	1 05	3 299	3 637	.533	806	270.	1.13	14	0230	.190
1	1 31	4 134	2 903	.866	1 357	166.9	1 67	11½	.0408	.349
1¼	1 66	5 215	2 301	1.496	2 163	96 25	2 25	11½	.0638	.527
1½	1 9	5 969	2 01	2 038	2 835	70 65	2.69	11½	.0918	.760
2	2 37	7 461	1 611	3.355	4 430	42 36	3.66	11½	1632	1 356
2½	2 87	9 032	1 328	4 783	6 491	30 11	5 77	8	2550	2.116
3	3 5	10 996	1 091	7 388	9 621	19 49	7 54	8	.3673	3 049
3½	4	12 566	955	9 837	12 566	14 56	9 05	8	4998	4 155
4	4 5	14 137	849	12 730	15 904	11 31	10 72	8	6528	5.405
4½	5	15 708	765	15 939	19 635	9 03	12 49	8	8263	6.851
5	5 56	17 475	629	19 990	24 299	7 20	14 56	8	1 020	8.500
6	6 62	20 813	577	28 889	34 471	4 98	18 75	8	1 469	12 312
7	7 62	23 954	505	38 737	45 663	3.72	23 41	8	1 999	16 662
8	8 62	27 096	444	50 039	58 426	2 88	28 34	8	2 611	21.750
9	9 68	30 433	.394	63 633	73 715	2 26	34 66	8	3 300	27.500
10	10 75	33 772	355	78 868	90 792	1 80	40 64	8	4 081	34.000

*The U. S. Standard gallon of 231 cubic inches.

CAST-IRON PIPE.

Safe Thickness of Metal and Weight per Length, including Bells, for Different Sizes and Under Various Heads of Water.

Size Inside diam.	25 ft. Head or 10.82 lbs Pressure		50 ft Head or 21.65 lbs Pressure		100 ft. Head or 43 30 lbs Pressure		150 ft Head or 64 95 lbs Pressure		200 ft Head or 86 60 lbs. Pressure		250 ft. Head or 108 25 lbs Pressure.		300 ft Head or 129 90 lbs Pressure.		Contents in gallons per ft. in length
	Thick's of Metal	Weight per Length	Thick's of Metal	Weight per Length	Thick's of Metal	Weight per Length	Thick's of Metal	Weight per Length	Thick's of Metal	Weight per Length	Thick's of Metal	Weight per Length	Thick's of Metal	Weight per Length	
2	.255	54	294	63	.312	67	330	72	348	76	366	81	384	86	163
3	.330	132	344	144	.253	141	362	153	371	157	380	161	390	166	.367
4	.335	180	361	197	573	204	385	211	397	218	.409	226	421	235	652
6	.375	300	393	315	411	330	429	345	447	361	465	377	483	393	1 469
8	.433	456	422	445	450	475	474	502	498	529	.522	557	546	584	2 611
10	.483	576	459	600	489	641	511	682	549	723	579	766	609	808	4 081
12	.446	720	491	768	527	826	563	885	598	944	.635	1004	671	1064	5 876
14	....	....	.524	952	5 6	1031	608	1111	.650	1191	692	1272	734	1352	7 997
16	....	....	.580	1215	604	1253	652	1360	700	1463	.748	1568	796	1673	10 44
18	....	....	.529	1370	643	1500	697	1630	751	1761	.805	1894	859	2026	13 22
20	....	....	.622	1603	682	1763	742	1924	.802	2086	.862	2249	923	2412	16 32
24	....	....	.687	2130	759	2349	831	2580	903	2911	.975	3045	1 047	3279	23 80
30	....	....	.785	3020	875	3376	965	3735	1 055	4095	1 145	4458	1 235	4822	36 72
36	....	....	.882	4070	970	4581	1 058	5096	1.206	5613	1.314	6133	1 422	6656	52 68
48	....	....	1.078	6616	1 223	7521	1 366	8431	1 510	9340	1.654	10269	1.798	11195	94.02

All pipes cast in length of 12 feet, except the 2 inch, which are cast 9 feet long.
Pipes with flanges weigh about 15 per cent. more than above.
Packing of Rubber for flanged pipe is usually ⅛ in. thick and weighs about 20 lbs. to the sq. yd.
☞ For Friction of Water in Pipes, etc., see next page.

FRICTION OF WATER IN PIPES.

Friction-loss in Pounds Pressure per square inch, for each 100 feet of length in different size clean Iron Pipes discharging given quantities of Water per minute. G. A. Ellis, C. E.

Gals per minute.	Sizes of Pipes—Inside Diameter.															
	¼ *In.*	½ *In*	¾ *In*	1 *In*	1¼ *In*	1½ *In*	2 *In*	2½ *In*	3 *In.*	4 *In.*	6 *In*	8 *In*	10 *In*	12 *In*	14 *In*	16 *In*	18 *In*
5	3 3	0 84	0 31	0 12													
10	13 0	3 16	1 05	0 47	0 12												
15	28 7	6 68	2 38	0 97													
20	50 4	12 3	4 07	1 66	0 42												
25	78 8	19 0	6 40	2 62				0 21	0 10	,027							
30		27 5	9 15	3 75	0 91												
35		37 0	12 4	5 05													
40		48 0	16 1	6 52	1 60			0 20									
45			20 2	8 15													
50			24 9	10 0	2 44		0 81	0 35	0 09								
60			56 1	22 4	5 32		1 80	0 74	0 23								
70				30 0	9 46		3 20	1 31	0 33	0 05							
75					14 9		4 89	1 99									
100					21 2		7 0	2 85	0 60	0 10							
125					29 1		9 46	3 85									
150					37 5		12 47	5 02	1 22	0 17							
200							19 66	7 76	1 89	0 26	0 07	0 03	0 01				
250							28 06	11 2	2 66	0 37	0 09	0 04					
300								15 2	3 65	0 50	0 12	0 05	0 02				
400								19 5	4 73	0 65	0 16	0 06					
500								30 8	7 43	1 02	0 25	0 09	0 04	0 017	0 009	0 005	
750										2 21	0 53	0 18	0 08				
1000										3 88	0 92	0 32	0 13	0 062	0 036	0 020	
1250											1 46	0 49	0 20				
1500											2 09	0 70	0 29	0 135	0 071	0 040	
1750												0 95	0 38				
2000												1 23	0 49	0 234	0 123	0 071	
2250													0 63				
2500													0 77	0 362	0 188	0 107	
3000													1 11	0 515	0 267	0 150	
3500														0 697	0 365	0 204	
4000														0 910	0 472	0 263	
4500															0 593	0 333	
5000															0 730	0 408	

AREAS OF CIRCLES.

Diam	Area	Diam	Area	Diam	Area	Diam	Area	Diam	Area	Diam	Area	Diam	Area
	0 12	4 in	12 57	1 in	132 73	22 in	380 13	31 in	754 7	40 in	1256 6	49 in	1885
	0 49		15 90		143 13		397 60		779 3		1288 2		1924 4
	1 10	5 in	19 63	14 in	153 94	23 in	415 47	32 in	804 2	41 in	1320 2	50 in	1963
	1 96		23 76		165 13		433 73		829 5		1352 6	½	2002 9
	4 41	6 in	28 27	15 in	176 71	24 in	452 39	33 in	855 3	42 in	1385 4	51 in	2042 8
¼	7 85		33 18		188 69		471 43		881 4	½	1418 6		2083 0
½	9 04	7 in	38 48	16 in	201 06	25 in	490 9	34 in	907 9	43 in	1452 2	52 in	2123 7
¾	1 227		44 17		213 82		510 7		934 8		1488 1	½	2164 7
1	1 767	8 in	50 26	17 in	226 98	26 in	530 9	35 in	962 1	44 in	1520 5	53 in	2206 2
¼	2 405		56 74		240 52		551 5		990 8	½	1555 2		2248 0
2 in	3 141	9 in	63 61	18 in	254 47	27 in	572 5	36 in	1017 8	45 in.	1590 4	54 in	2290 2
¼	3 976		70 88		268 80	½	593 9		1046 3	½	1625 9	½	2332 8
½	4 908	10 in	78 54	19 in	283 53	28 in	615 7	37 in	1075 2	46 in	1661 9	55 in	2375 8
¾	5 939		86 59		298 64		637 9		1104 4	½	1698 2	½	2419 2
3 in	7 07	11 in	95 03	20 in	314 16	29 in	660 5	38 in	1134 1	47 in	1734 9	56 in	2463 0
¼	8 29		103 87		330 06	½	683 4	½	1164 1	½	1772 0	½	2507 2
½	9 62	12 in	113 10	21 in	346 36	30 in	706 8	39 in	1194 6	48 in	1809 6	57 in	2551 7
¾	11 04		122 71		363 05	½	730 6	½	1225 8	½	1885 8	½	2596 7

[redacted]

To Correspondents.

In order to give definite information concerning electrically operated pumping apparatus of any description, we should be fully posted on the following points:

1. What is the liquid to be pumped; is it hot or cold, clear or gritty, fresh, salt, alkaline, or acidulous?
2. What is the maximum quantity to be pumped per minute or hour?
3. To what height is the liquid to be lifted by suction; and what is the length and diameter of the suction pipe, and the number of elbows or bends?
4. To what height is the liquid to be pumped, and what is the length and size of discharge pipe?
5. Is the delivery stated above to be practically continuous, or only occasional? What is the average service expected?
6. Is an automatic starting and stopping device to be used? If so, upon what will its operation depend?
7. What is the nature of the electric current to be used? Direct or alternating? Voltage? (If alternating, give phase and number of alternations).
8. Are there any unusual or peculiar circumstances connected with the installation or operation of the apparatus; and if so, what?

☞ Full particulars of any standard type of apparatus can be promptly obtained by using the telegraphic code on the pages 38 and 39. Care should be taken, however, to read and follow the directions carefully in order to avoid confusion and delay.

Directions for Setting up and Running Pumps.

Never use pipes of smaller size than are called for in the tables; when long pieces are used, it is necessary to increase the diameter to allow for the increased friction. Observe this suggestion, especially in regard to *suction pipes.*

Use as few elbows, T's and valves as possible, and run every pipe in as direct a line as practicable; when convenient, use full round bends rather than elbows; use Y's instead of T's when possible. Bends, returns, T's and elbows increase friction more rapidly than length of pipe.

Care should be taken to guard against leaks in the suction pipe, as a very small leak destroys the effectiveness of the suction of a pump.

See to it that a full supply of water is constantly furnished the pump. To prevent the pump from freezing in cold weather, care should be taken to open the drip plugs and cocks—which are provided for the purpose of draining the pump.

Water at a high temperature cannot be raised any considerable distance by suction. For pumping very hot water, place the supply high enough, so that the water will gravitate to the pump.

A large suction chamber placed on the suction pipe immediately by the pump is very advantageous, and for pumps running at high speed it is a *necessity.* Keep the stuffing boxes nicely packed.

Ordinary speed to run pumps is not over 100 feet piston travel per minute. For continuous boiler-feeding service, about half that speed is recommended.

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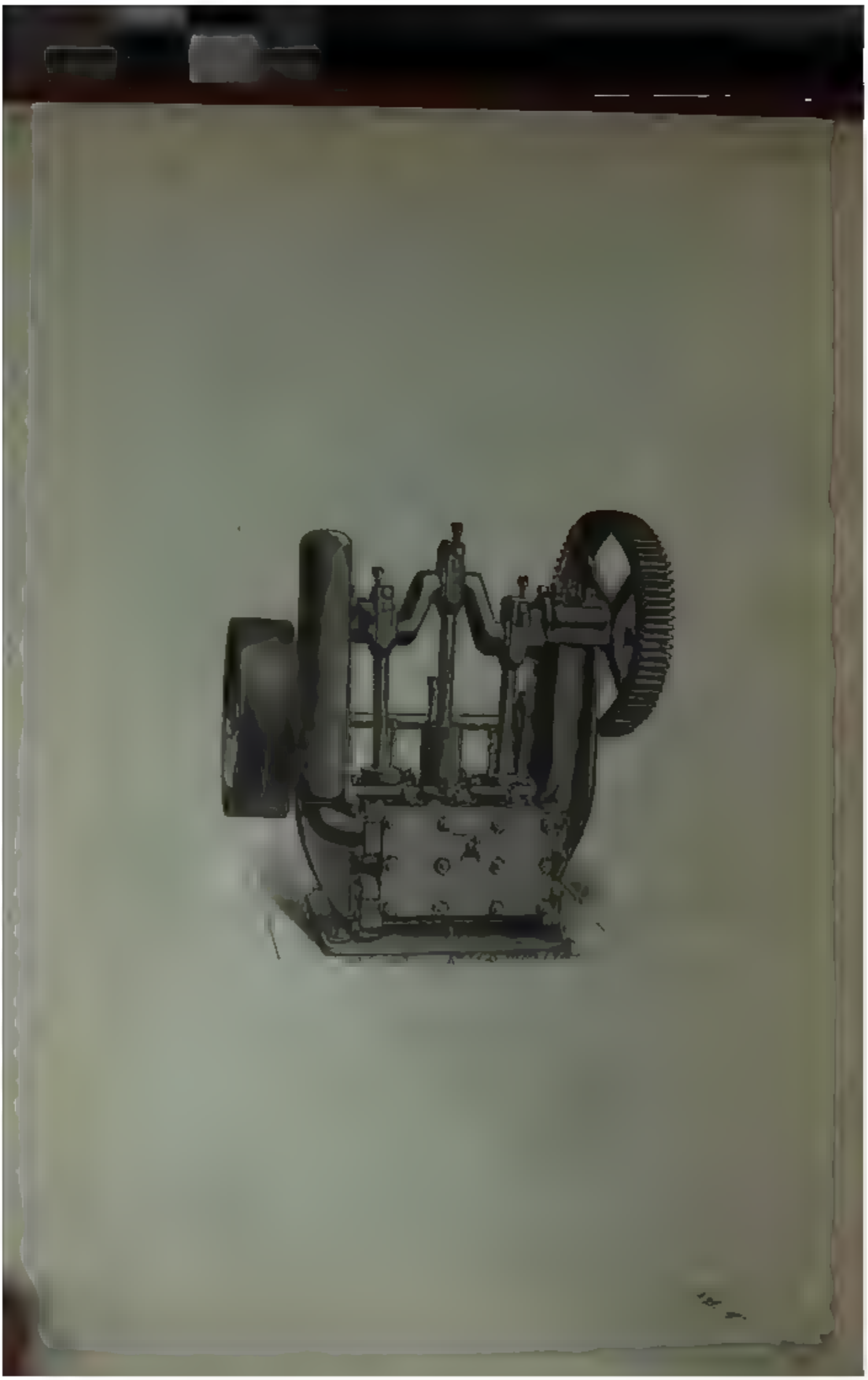
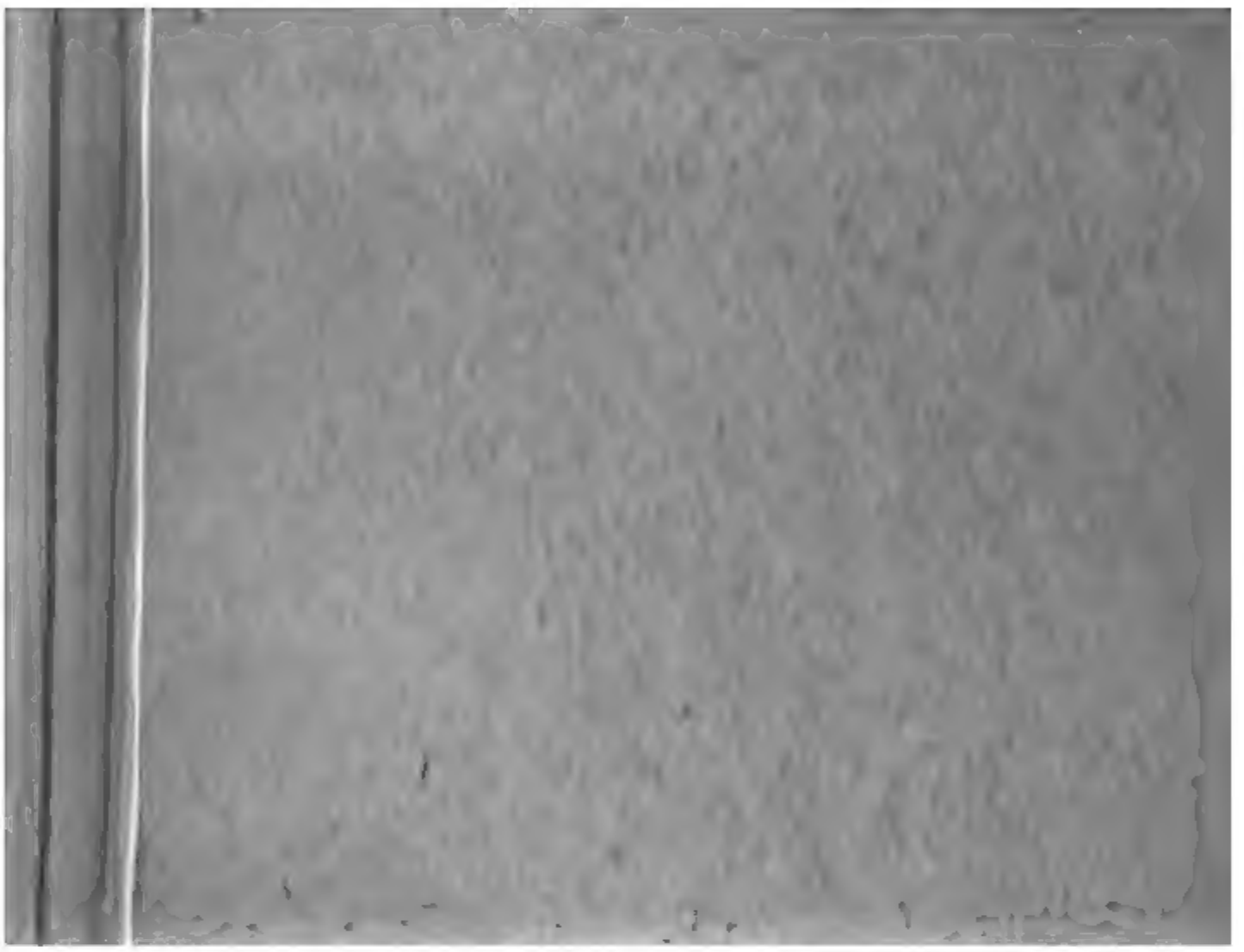
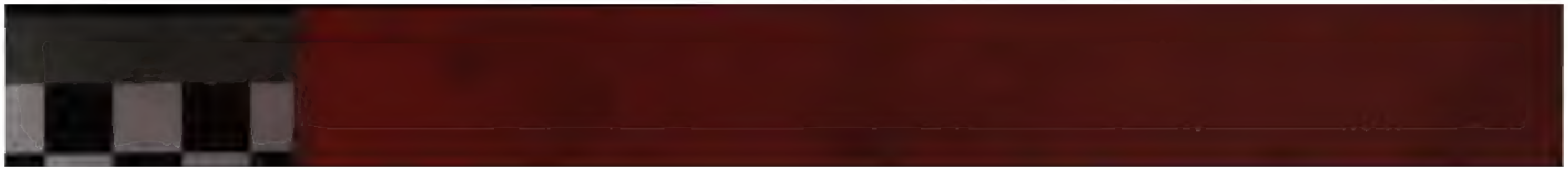
NOTE.—This is a special catalogue, showing a few patterns only of our power pumps, especially adapted for operation by electric motors. For pumping apparatus of every variety and for all classes of service, air compressors, condensers, etc., etc., see the

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